Office of the Deputy Under Secretary of Defense for Environmental Security

Disease Vector Ecology Profile

Bolivia

Defense Pest Management Information Analysis Center
Armed Forces Pest Management Board
Forest Glen Section
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Washington, DC 20307-5001

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PREFACE

Disease Vector Ecology Profiles (DVEPs) summarize unclassified literature on medically important arthropods, vertebrates and plants that may adversely affect troops in specific countries or regions around the world. Primary emphasis is on the epidemiology of arthropod-borne diseases and the bionomics and control of disease vectors. DVEPs have proved to be of significant value to commanders, medical planners, preventive medicine personnel, and particularly medical entomologists. These persons use the information condensed in DVEPs to plan and implement prevention and control measures to protect deployed forces from disease, injury, and annoyance caused by vector and pest arthropods. Because the DVEP target audience is also responsible for protecting troops from venomous animals and poisonous plants, as well as zoonotic diseases for which arthropod vectors are unknown, limited material is provided on poisonous snakes, noxious plants, and diseases like hantavirus.

Vector-borne diseases are presented in two groups: those with immediate impact on military operations (incubation period < 15 days) and those with delayed impact on military operations (incubation period > 15 days). For each disease, information is presented on military importance, transmission cycle, vector profiles, and vector surveillance and suppression.

Similar information on venomous vertebrates and noxious plants is available in the Armed Forces Medical Intelligence Center's (AFMIC) Medical, Environmental, Disease, Intelligence, and Countermeasures (MEDIC) CD-ROM.

Contingency Operations Assistance: The Armed Forces Pest Management Board (AFPMB) is staffed with a Contingency Liaison Officer (CLO), who can help identify appropriate DoD personnel, equipment, and supplies necessary for vector surveillance and control during contingencies. Contact the CLO at Tel: (301) 295-8300, DSN: 295-8300, or Fax: (301) 295-7473.

Defense Pest Management Information Analysis Center (DPMIAC) Services: In addition to DVEPs, the DPMIAC publishes Technical Information Bulletins (TIBs), Technical Information Memoranda (TIMs), and the Military Pest Management Handbook (MPMH). The DPMIAC can provide online literature searches of databases on pest management, medical entomology, pest identification, pesticide toxicology, and other biomedical topics. DPMIAC also operates a home page on the Internet, from which documents of current operational interest, such as TIMs, DVEPs, and recent editions of TIBs can be downloaded. Customers can also conduct their own literature abstract data searches online. The home page address is: **http://www.afpmb.org**/. Contact DPMIAC at Tel: (301) 295-7476, DSN: 295-7476, or Fax: (301) 295-7483. Additional hard copies or diskettes of this publication are also available.

Other Sources of Information: The epidemiologies of arthropod-borne diseases are constantly changing, especially in developing countries undergoing rapid growth, ecological change, and/or large migrations of refugee populations resulting from civil strife. Therefore, DVEPs should be supplemented with the most current information on public health and geographical medicine. Current disease risk assessments, additional information on parasitic and infectious diseases, and other aspects of medical intelligence can be obtained from the Armed Forces Medical

Intelligence Center (AFMIC), Fort Detrick, Frederick, MD 21701, Tel: (301) 663-7511, DSN: 343-7511. Disease Risk Assessment Profiles (DISRAPs) and Vector Risk Assessment Profiles (VECTRAPs) for most countries in the world can be obtained from the Navy Preventive Medicine Information System (NAPMIS) by contacting the Navy Environmental Health Center (NEHC) at Tel: (804) 444-7575 ext. 456, DSN: 564-4657 ext. 456. Information is also available from the Defense Environmental Network and Information Exchange (DENIX) home page address: **http://denix.cecer.army.mil/denix/denix.html**

Specimen Identification Services: Specimen identification services and taxonomic keys can be obtained through the Walter Reed Biosystematics Unit (WRBU), Museum Support Center, MRC-534, Smithsonian Institution, Washington, DC 20560 USA; Tel: (301) 238-3165; Fax: (301) 238-3667; e-mail: wrbu@wrbu.si.edu

Emergency Procurement of Insect Repellents, Pesticides and Equipment: Deploying forces often need pesticides and equipment on short notice. The Defense Logistics Agency (DLA) has established the following Emergency Supply Operations Centers (ESOCs) to provide equipment and supplies to deploying forces:

For insect repellents, pesticides and respirators: Contact the Defense General Supply Center ESOC at Tel: (805) 275-4865, DSN: 695-4865. The ESOC is staffed seven days a week/24 hours a day.

For application equipment: Contact the Defense Construction Supply Center ESOC at Tel: (614) 238-2271/3191, DSN: 850-2271/3191.

For personal protection equipment (bednets, headnets, etc.): Contact the Defense Personnel Support Center at Tel: (215) 737-3042/3043, DSN: 444-3042/3043.

Every effort is made to ensure the accuracy of the information contained in DVEPs. Individuals having additional information, corrections, or suggestions, are encouraged to provide them to the Chief, DPMIAC, Armed Forces Pest Management Board, Forest Glen Section, Walter Reed Army Medical Center, Washington, DC 20307-5001; Tel: (301) 295-7476, DSN: 295-7476; Fax: (301) 295-7483.

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I. Executive Summary

Bolivia is divided into three major regions: the western **Altiplano** or high plateau (average elevation 3,800 m and temperature 11°C/50° F), the **Yungas**, a series of forested valleys on the eastern slopes of the Andean Altiplano (490-3,130 m elevation and average temperature 21°C/ 70° F), and the **Llanos**, or lowlands of eastern Bolivia that vary in topography and climate. The climatic and geographic diversity largely dictates the distribution of vector-borne diseases that could interfere with military or humanitarian operations.

Malaria, transmitted by the bite of infected *Anopheles* mosquitoes, is endemic countrywide and year-round below elevations of 1,000 m and during September through April at higher elevations below 2,500 m. The greatest threat is in the Departments of Beni, Pando, Tarija and the northern region of Santa Cruz. There is little or no threat in Oruro, southern and central Potosí, highlands of LaPaz, and in the cities of Cochabamba, Sucre, and Santa Cruz. *Plasmodium falciparum* is resistant to the antimalarial drugs chloroquine and Fansidar®, particularly in the north-central lowlands. Preventive measures against malaria include sanitation improvements to eliminate mosquito breeding sites, application of residual insecticides to vector resting sites, use of aerosol insecticides to screened living and sleeping areas, use of permethrin-impregnated bednets for sleeping, prompt and effective treatment of cases and conscientious use of chemoprophylaxis and personal protective measures (**PPM**). **PPM** are outlined in Appendix H.

Dengue fever can debilitate its victims as early as 3 days following the bite of an infected *Aedes aegypti* mosquito. The greatest risk is in urban areas below 1,200 m, especially during the wet season (November/December through March). Individuals who are serologically positive for the dengue virus are in greater danger of developing the more serious dengue hemorrhagic fever/ dengue shock syndrome (DHF/DSS), if infected a second time. Eliminate larval breeding sources (artificial containers), spray interiors of tentage with permethrin, and use **PPM** against mosquitoes.

Eastern equine encephalitis (EEE), **Mayaro virus**, and **Oropouche** are arthropod-borne viral diseases that have the potential to produce many casualties. EEE and Mayaro are transmitted by mosquitoes and Oropouche by biting midges. Mayaro (in the eastern lowland rain forests) and Oropouche (in urban and suburban areas associated with banana and cacao plantations) may rapidly cause many cases. EEE has occurred in the Departments of Beni and the extreme northern area of Santa Cruz and may be more serious for the soldier. Numerous other poorly known arboviral diseases occur in the Amazon Basin. Highest risk occurs during the rainy season (November/December - March). Bivouac away from banana and cacao plantations, apply insecticide to vegetation and breeding areas in and around encampments, and use **PPM** against biting midges and mosquitoes.

Leishmaniasis is a protozoan disease transmitted in the New World by species of *Lutzomyia* sand flies. Since sand flies have very short flight ranges, area control through applications of residual insecticides is effective. Sand flies bite primarily during hours of darkness, although they will bite during the day if hosts enter their resting habitat. Leishmaniasis occurs year-round east of the Andes in areas below 2,000 m. Peak vector populations occur during the spring (September to December). Avoid bivouacking in densely forested areas, or close to human habitations, apply residual insecticide barrier sprays, and use **PPM**, particularly during hours of darkness.

Chagas disease, transmitted by kissing bugs associated with substandard housing (e.g., thatched and adobe shanties), is prevalent in urban slums and rural areas. Overall infection rates in Bolivia are reportedly the highest in the Americas, and the disease occurs in rural areas (including the Altiplano) up to 3,600 m. Bivouac away from domestic and peridomestic settings. Use **PPM** to protect against feeding kissing bugs.

Relapsing fever (louse-borne) was reported sporadically in the early 1970's from Beni Department. **Epidemic typhus**, also transmitted by body lice, was reported from scattered foci in the contiguous Departments of Chuquisaca, Cochabamba, LaPaz, and Oruro. Both diseases proliferate under crowded and unsanitary conditions resulting from the chaos of wars, civil strife, and natural disasters. Avoid contact with potentially infested populations, and use **PPM**.

Relapsing fever (tick-borne) is indicated by positive human serologies from Santa Cruz Department. Avoid use of local dwellings and use **PPM** to prevent bites of *Ornithodoros* ticks.

Plague, transmitted by the bites of fleas, is focally enzootic in Chuquisaca, LaPaz, Santa Cruz, and Tarija Departments. Avoid bivouacking in rodent-infested habitats, and using local dwellings for shelter. Practice good sanitation and control commensal rodents in camp areas. Use **PPM** against fleas.

Lyme disease, transmitted by ticks, is indicated serologically in the Department of Santa Cruz. Use **PPM** against ticks, check for ticks frequently, and remove embedded ticks without delay.

Yellow fever, a mosquito-borne virus, occurs year-round, but most cases are contracted in jungle areas east of the Andes during the wet season. An effective vaccine is available.

Several zoonoses also occur in Bolivia. **Hantavirus pulmonary syndrome** and **Bolivian hemorrhagic fever** are contracted when broken skin or mucous membranes come in contact with infected rodent urine or feces via contaminated surfaces, food, or water. Avoid rodent-infested habitats or eating food contaminated by rodents, and eliminate food, water and harborage required by rodents. **Brucellosis,** transmitted via infected unpasteurized dairy products, is endemic countrywide. Avoid unpasteurized milk or milk products from local cattle and goats. **Rabies** is highly endemic. Avoid cats, dogs, and bats.

Venomous snakes, poisonous arthropods, and toxic and irritating plants are present throughout Bolivia. Ticks, chiggers, and fleas are sources of significant discomfort. Fleas are associated with human habitations with free-roaming pigs, chickens, and dogs. Ticks and chiggers are more prevalent in secondary growth or scrub vegetation, especially along forest edges. Severe irritation and scratching may result in secondary infections. Apply residual pesticides to bivouac areas and use **PPM** against ticks, chiggers and fleas. Teach troops to recognize and avoid contact with poison ivy and other poisonous plants.

II. Map of Bolivia (CIA)

III. Country Profile

A. Geography. Bolivia, a republic in west central South America, is bordered by Brazil to the north and east, Paraguay and Argentina on the south, and Chile and Peru on the west. The country has no direct access to the sea. With an area of 1,100,000 km^2 (425,000 $mi.^2$), it is about three times the size of the state of Montana and the fifth largest nation in South America after Brazil, Argentina, Peru, and Columbia. Bolivia's major cities are La Paz (the administrative capital), Sucre (the judicial center), Santa Cruz and Cochabamba. The diverse geography of Bolivia may be divided into 3 major regions: the altiplano or high plateau, the yungas, a series of forested valleys on the eastern slopes of the Andes which descend into the third region, the llanos, the lowlands of eastern Bolivia. The altiplano crosses the country from the northwest to the southeast and parallels and splits the Andes into two mountain chains (cordilleras) along its eastern and western sides. The western mountain chain (Cordillera Occidental) forms a 5,000 m (16,500 ft.) high frontier with Chile. On the northeast is the Cordillera Real with some of the highest mountains in the Andes chain. The altiplano, about 800 km (500 mi.) long and 130 km (80 mi.) wide, has an average altitude of 3,650 m (12,000 ft.) above sea level. The north end of this plateau, where the bulk of the population and industry are found, cradles the world's highest navigable lake, Lake Titicaca at 3,800 m (12,500 ft.), and the lithium-rich Uyuni and Copipasa salt flats. The rivers in the altiplano form an internal, closed system with all flow into Lake Titicaca, Lake Poopó, or the salt flats further south. To the south, the altiplano becomes arid. The high altitude gives the plateau a clear atmosphere and cool climate. The average temperature is 10° C (50° F). Cereals are the altiplano's major agricultural products. Livestock include sheep, alpacas, llamas, and vicuñas.

In the Departments of La Paz and Cochabamba, the yungas lying along the eastern margin of the Cordillera Real, vary in altitude from 490 to 3,130 m (1,600-9,000 ft.). This area separates the high plateau from the lowland plains to the north and east. The temperature averages about 21° C (70° F), and the humidity is high. Further south, in the Departments of Chuquisaca, Tarija, and western Santa Cruz, the yungas flatten out into more open and cooler valleys that descend gradually toward the Chaco plains in the southeast.

The tropical lowland plains region (llanos) makes up more than two-thirds of the national territory of Bolivia. This area comprises the Departments of Beni, Pando, and Santa Cruz. This is the most highly developed agricultural region in Bolivia. In the northeastern area, these plains are part of the Amazon River basin and contain tropical forests and dense vegetation interspersed with open savannas. During the wet season (November/December, to March), much of this area is flooded or swampy. Further south, and separated from the Amazonian lowlands by the Chiquitos highlands (ca. 1,000 m or 3,500 ft.), lie the dry, semitropical plains of Chaco. These plains form part of the La Plata River basin and constitute a northward extension of the Argentine pampas. This sparsely populated part of Bolivia is rapidly developing. Large-scale cotton and sugarcane farming and cattle raising predominate, but interest in industrial development is increasing. Bolivia's major deposits of petroleum, natural gas, and iron ore are located in this region.

B. Climate. In general, the climate varies with altitude from humid-tropical in the lowlands to cold and semiarid on the plateau. Rainfall increases from west to east and from south to north, with considerable seasonal and year-to-year variations. The Andean ranges and the altiplano have harsh, dry, generally cold climate with little rainfall. While there is little seasonal variation at these altitudes, night and day temperatures vary a great deal. Daytime temperatures range between 10 and 16° C and from –1 to 4° C at night, with frosts occurring through the year. The yungas are warm and subtropical, receiving rainfall all year. The Departments of Beni and Pando in the northern Oriente are relatively hot and humid. Further south, the Chaco region has a number of rivers flowing through it during the rainy season, but it is practically a desert during the rest of the year. Flooding and drought are both common in Bolivia.

Tables 1 and 2 present meteorological summaries for the cities of La Paz and Concepción, representative of the yungas and llanos, respectively.

Table 1. 31-year meteorological summary at La Paz (3,658 m/12,001 ft).

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Highest Temp. (°C)	25	24	24	24	22	21	22	22	27	24	25	24
Av. Maximum (°C)	17	17	18	18	18	17	17	17	18	19	19	18
Av. Minimum (°C)	6	6	6	4	3	1	1	2	3	4	6	6
Lowest Temp. (°C)	1	2	2	-1	-1	-3	-3	-3	-1	-1	-1	2
Av. Rainfall (mm)	114	107	66	33	13	8	10	13	28	41	48	94

Table 2. 5-year meteorological summary at Concepción (490 m/1,607 ft).

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Highest Temp. (°C)	36	34	34	34	34	32	34	36	38	37	38	34
Av. Maximum (°C)	29	30	29	30	28	27	27	31	33	31	31	30
Av. Minimum (°C)	19	19	18	17	15	13	12	13	16	17	19	18
Lowest Temp. (°C)	13	9	12	9	6	7	2	4	4	7	11	8
Av. Rainfall (mm)	193	155	117	61	79	23	28	15	58	76	206	132

C. Population/People. The population of Bolivia is 7.7 million with an annual growth rate of 2.04% (July 1997 estimates, The World Fact Book, 1997). Forty percent of the people live in the altiplano, 35% in the highland valleys associated with La Paz (803,000), Cochabamba (456,000), Oruro (207,000), Sucre (148,000), Potosi (127,000), and Santa Cruz (784,000), and 25% in the eastern plains. The urban population represents 61% of the national total. The southwestern regions of the Departments of Potosí and Oruro, northern La Paz, and Pando, Beni, and Santa Cruz are sparsely populated. Countrywide, there are 7 persons per km^2 (18/ $mi.^2$), one of the lowest population densities in South America. Ninety-five percent of the population is Roman Catholic with ethnic groups totaling 30% Quechua, 25% Aymara, 25-30% mestizo (mixed white and Amerindian), and 5-15% white. The official languages are Spanish, Quechua, and Aymara. The literacy rate is 78%.

D. Living and Sanitary Conditions. The bulk of the population lives at a marginal subsistence level. As of 1994, 94% of the rural population did not have electricity, municipal water, or sewage connections. Migration to larger urban centers has contributed to the growth of slums. In urban areas, sewage collection facilities are not available for more than 60% of the population. Most refuse is dumped into rivers and streams, although some urban areas regularly collect garbage for disposal in landfills. Housing shortages exist, and housing, generally of substandard quality, varies with the geographic region. Housing in highland areas is mostly small adobe buildings with earthen floors. Housing in the lowlands tends to be less durable than that in the highlands.

1. Pollution: Fecal contamination of waterways is the most significant pollution problem. Although air pollution is not a serious problem, industrial point-source emissions contribute to degradation of urban air quality.

2. Water: Surface water sources, including rivers, streams, lakes and wells, are the predominant sources of drinking water for both rural and urban Bolivians. Urban water treatment (usually filtration only) and distribution systems are unreliable in Bolivia. More than 40% of urban residents and 95% of rural residents do not have access to municipal water services. Water management is difficult during the rainy season (November/December to March) in the lowland areas east of the Andes.

IV. Militarily Important Vector-Borne Diseases with Short Incubation Periods (<15 days)

A. Malaria. Malaria is a protozoan blood parasite transmitted to man by the bite of infective *Anopheles* mosquitoes. Two of the four human malaria species occur in Bolivia: *Plasmodium falciparum* and *Plasmodium vivax*. *Plasmodium falciparum* (malignant tertian), the most serious of the four malarias, frequently causes death (10% in untreated non-immune adults). *Plasmodium vivax* (benign tertian) is generally not life threatening but may result in complete debilitation during manifestations of clinical symptoms. Some *P. vivax* parasites may remain in the liver cells for months or even years following the initial clinical disease. Consequently, relapses producing clinical malaria may occur months to years later. Relapses usually do not occur with *P. falciparum*. Lack of treatment, drug resistant strains, or inadequate therapy may result in relapses of all malaria species. Clinical symptoms of malaria vary with the species. Falciparum malaria may produce fever, chills, sweats, cough, diarrhea, respiratory distress and headache, often leading to more serious systemic complications. Vivax malaria may begin with general malaise and a slowly rising fever of several days duration, followed by shaking chills, rapidly rising temperature, usually accompanied by headache and nausea, and end in profuse sweating. The fever subsides for a period and is followed by subsequent cycles of fever, chills, and sweating.

1. Military Impact and Historical Perspective. The number of cases of malaria in Bolivia more than tripled from 1990 to 1996 (19,680 to 64,135 cases). Seventy-one percent of the 1996 cases (45,309) occurred in the Departments of Pando, Tarija, and Beni. Other heavily endemic Departments were Santa Cruz (8,255), Chuquisaca, LaPaz, and Cochabamba, each with over 3,000 cases. In addition, the percentage of *P. falciparum* nearly tripled from 1981 to 1994 (5% to 13.7%). Malaria is considered endemic in those portions of the country below 2,000 m. The national spray program for control of malaria vectors included no chemical treatment of houses from 1990-92, few in 1993-95, and none in 1996. Currently, 80% of the cases are *P. vivax* and the remaining 20% *P. falciparum*. The impact of malaria on unit operational readiness, particularly in lowlands east of the Andes, could be devastating. Historically, malaria afflicted up to 40% of some Army units in Vietnam. Commanders lost 2 of every 5 men for substantial periods of time, seriously compromising their missions. The threat in Bolivia is equally great, compounded by known *P. falciparum* resistance to chloroquine and Fansidar® in some areas. Fortunately, malaria is largely preventable and casualties can be minimized by implementing the measures outlined in paragraph IV.A.4.

2. Transmission Cycle. Humans are the sole reservoir for human malaria parasites (*P. vivax*, *P. falciparum*, *P. malariae* and *P. ovale*). Female mosquitoes of the genus *Anopheles* are the exclusive vectors of human malaria. During feeding, the mosquito ingests the sexual stages of the parasite (male and female gametocytes), which unite and form an ookinete that penetrates the midgut of the mosquito, forming an oocyst. The oocysts produce thousands of sporozoites, some of which migrate to the salivary glands and are injected into the human host on subsequent feedings. The time between ingestion of sexual gametocytes and liberation of sporozoites is dependent on the temperature and species of malaria parasite (8-35 days). Cooler temperatures that occur with increased altitudes will increase the time for development. Ingested sporozoites travel to the liver where they invade the liver cells and divide, becoming asexual merozoites. After several division cycles, the merozoites leave the liver cells and parasitize individual red blood cells (RBCs). Most become schizonts that cyclically rupture the RBCs, causing the characteristic symptom of "fever and chills." Some of the merozoites develop into sexual male and female gametocytes capable of infecting other *Anopheles* mosquitoes. Once infected, mosquitoes remain infective for life. Infected humans are potential reservoirs of infection as long as the sexual gametocytes are circulating in the blood. In vivax malaria, this is only 1-2 days after onset of symptoms as opposed to 10-12 days after onset in falciparum malaria.

3. Vector Ecology Profile. Important vectors of malaria in Bolivia are *An. darlingi*, *An. pseudopunctipennis*, *An. nuneztovari*, *An. triannulatus*, *An. marajoara*, and *An. braziliensis*. Relative importance may be determined by seasonal and/or geographic distribution. Vector ecology profiles for these species are presented in Appendix A.1. Cryptic or sibling species of some anophelines in the Americas warrant careful scrutiny to determine which are vectors in a given field situation. For example, *An. nuneztovari* is a recognized species complex in Venezuela.

4. Vector Surveillance and Suppression. Larval and adult surveillance techniques are used to assess mosquito populations. Consult the vector ecology profiles in Appendix A.1 for mosquito species of concern and adapt larval surveys to breeding habitats of these species. Larval sampling, using a white dipper equipped with a long handle, will facilitate collection of *Anopheles* larvae. Systematically performed, larval dipping will provide data on species composition and population dynamics on which to base control measures. Adult surveillance of potential anopheline vectors principally includes collection from animal or human bait or collection of resting adults using mechanical or mouth aspirators (Note: collections using human bait must be conducted under approved human-use protocols). Military operations may be more concerned with exophilic anopheline populations, necessitating the collection of mosquitoes away from domestic locations. Anthropophilic species can also be collected in active searches of resting sites in and around human dwellings using a mouth or mechanical aspirator and aided by a flashlight. Collections from any source are suitable for determining species composition and abundance, parity rates, and malaria parasite infection rates. The older the female anopheline mosquito population is in a malaria-endemic area, the greater the potential for transmission, since the man-mosquito-man cycle requires a minimum of 8-9 days. Malaria suppression should include elimination of gametocytes from blood of the human reservoir population, reduction of *Anopheles* mosquito populations, and prevention of mosquito bites. Mosquitoes are capable of acquiring *P. vivax* gametocytes from infected humans for 24-36 hours after treatment with chloroquine alone, but when treated concurrently with chloroquine and primaquine, the acquisition window is reduced to less than 4 hours. *Plasmodium falciparum* gametocytes are not killed by Fansidar®, quinine, or quinine plus tetracycline. Patients are known to infect mosquitoes for >30 days after successful treatment of erythrocytic stages. Primaquine is required to kill gametocytes and reduce transmission to new mosquito reservoirs. In Bolivia, *P. falciparum* resistance to chloroquine is reported in northeastern areas of Pando and Beni Departments, in the adjacent Brazilian town of Guajará-Mirim, and likely in all *P. falciparum* endemic areas. There also have been a few reported cases of *P. falciparum* resistant to Fansidar® in extreme northeastern areas. It is critically important for commanders to enforce medical protocols for administration of antimalarial drugs. Consult TIM 24 for chemicals, equipment, and procedures for controlling larval and adult mosquitoes. *Anopheles pseudopunctipennis* and *An. triannulatus* are reportedly resistant to DDT (WHO, 1992). **Personal Protective Measures** to prevent mosquito bites include minimizing exposed skin by wearing permethrin-treated BDUs with sleeves rolled down (particularly after sunset), using extended-duration deet repellent on the skin, wearing headnets impregnated with permethrin or deet, and sleeping under permethrin-treated bednets whenever possible (Appendix H and TIM 36).

B. Dengue Fever. Dengue fever (Flaviviridae: Flavivirus) is a viral illness transmitted in the Americas by the bite of the *Aedes aegypti* mosquito. Symptoms of dengue appear 3-14 days following the bite and include sudden onset of fever, severe headache, muscle and joint aches, retro-orbital pain, loss of appetite, gastrointestinal upset and, in some cases, generalized erythema and rash. There are four serotypes of the dengue virus (DEN-1, 2, 3 and 4). Serotypes are extremely important when considering clinical illness. There is lifelong immunity to subsequent exposure to the same (homologous) serotype, whereas an individual is predisposed to the more serious and often fatal dengue hemorrhagic fever (DHF), or dengue shock syndrome (DSS), if exposed to a different (heterologous) serotype. There are no vaccines for protection against dengue virus.

1. Military Impact and Historical Perspective. The greatest risk is in urban areas below 1,200 m. An outbreak of DEN 1, in the city of Santa Cruz in December 1987 to March 1988, resulted in nearly 7,000 confirmed cases and more than 150,000 suspected cases. Santa Cruz and Tarija Departments were affected. DEN 2 and 4 are also present in the endemic regions. Dengue fever can infect large numbers in a short period of time, rendering soldiers unfit for duty for a week or more. While morbidity rates for nonimmune personnel are high, complications of DHF/DSS are uncommon. When operating in endemic urban and peri-urban localities, it is crucial to use **PPM** to prevent inoculation by day-biting *Ae. aegypti.*

2. Transmission Cycle. Both humans and mosquitoes serve as reservoirs in the human-mosquito cycle. *Aedes aegypti*, the primary vector of dengue in the Americas, may acquire the virus from a viremic person immediately prior to and during the febrile period (about 6-7 days). The mosquito is able to transmit the virus 8-12+ days after acquisition, depending on temperature, and remains infective for life.

3. Vector Ecology Profile. The vector ecology profile for *Ae. aegypti* is presented in Appendix A.2.

4. Vector Surveillance and Suppression. Control of dengue fever is contingent upon managing populations of *Ae. aegypti* through surveillance, reduction of breeding sources, and treatment with insecticides. Surveillance should include monitoring adult egg-laying activity using black oviposition cups, searching interiors and exteriors of urban and peri-urban premises and encampment sites for water-filled containers harboring *Ae. aegypti* larvae, and conducting landing counts with a mechanical or mouth aspirator (TB MED 561). Eliminate breeding sources (any receptacle that may hold fresh water) from premises and encampment sites. Use ultra-low-volume (ULV) equipment and thermal foggers for large area control of adult populations. Consult TIM 24 for equipment and chemicals for control of mosquitoes. Cooler morning and evening hours are optimal times for applying fogs and aerosols to prevent the chemicals from being carried away by temperature-induced updrafts. Widespread resistance to organophosphates (chlorpyrifos, dimethoate, fenthion, malathion and temephos) is reported for *Ae. aegypti* (WHO, 1992). The individual soldier can prevent dengue fever by using **Personal Protective Measures** during the day when *Ae. aegypti* frequently bite. Wear permethrin-impregnated BDUs and use extended-duration deet repellent on exposed skin surfaces (TIM 36). When possible, avoid the practice of stripping to the waist or wearing shorts to keep cool during the daytime.

C. Yellow Fever. Yellow fever is caused by a flavivirus transmitted by mosquitoes. Symptoms of yellow fever occur 3-6 days following the bite of an infected mosquito. Patients may be nearly asymptomatic, but generally symptoms begin with sudden onset of fever, chills, headache, backache, generalized muscle pain, prostration, and vomiting and may progress to jaundice and hemorrhagic manifestations. Fatalities may exceed 50% in non-indigenous or non-immunized individuals. Yellow fever imparts a lifelong immunity to survivors.

1. Military Impact and Historical Perspective. In the Americas, virtually all cases of yellow fever in the past 55 years can be attributed to the sylvatic cycle. The disease has largely been eliminated from urban areas. It continues as focal enzootics and epizootics in the eastern areas of the Amazon River basin among native species of *Haemagogus* and *Sabethes* mosquitoes and a number of primate species. The most recent outbreaks occurred in 1996 and 1997 in the Departments of Beni, Cochabamba, northern LaPaz, and Santa Cruz from December through February (coinciding with the rainy season). The yellow fever vaccine provides soldiers essentially 100% protection; however, host country soldiers or allies may not have the same protection and may require entomological support.

2. Transmission Cycle. Yellow fever is propagated in either an urban cycle or a sylvatic cycle. During the urban cycle, the virus is transmitted between mosquitoes and humans. The sole mosquito vector is the domestic *Ae. aegypti.* Mosquitoes may acquire the virus from an infected person for a short time just before fever occurs and 3-5 days after onset. Mosquitoes require 9-12 days to become infective and remain so for life. The sylvatic cycle is a mosquito-monkey cycle, monkeys being the amplifying host. Primary vectors include canopy-dwelling species of *Haemagogus* and *Sabethes*, which transmit the virus to monkeys of the family Cebidae (howler monkeys, *Alouatta* spp., and spider monkeys, *Cebus* spp., *Aotes* spp. and *Callithrix* spp.). Maintenance of the virus in the sylvatic cycle is enhanced by transovarial transmission in vector mosquitoes. Urban yellow fever occurs when humans enter the jungle cycle, contract the disease from *Haemagogus* or *Sabethes* mosquitoes, and return to the urban areas where they infect *Ae. aegypti* that subsequently bite other urban residents. In the urban setting, humans are amplifying hosts for the virus.

3. Vector Ecology Profile. *Aedes aegypti* is the primary vector of yellow fever in the urban (mosquito-man) transmission cycle. *Haemagogus janthinomys, Hg. leucocelaenus, Hg. spegazzinii* and *Sabethes chloropterus* are vectors in the sylvatic (monkey-mosquito-man) cycle in Bolivia. The vector ecology profiles for these species are presented in Appendix A.2.

4. Vector Surveillance and Suppression. Methods for surveillance and suppression of yellow fever in the urban environment are the same as for dengue. Transmission of sylvatic yellow fever can be prevented by vaccination and using **Personal Protective Measures** to prevent species of *Haemagogus* and *Sabethes* from biting. Wear permethrin-impregnated BDUs with sleeves rolled down and use extended-duration deet repellent on exposed skin surfaces, especially during the daytime when these mosquitoes actively bite (TIM 36 and Appendix H). When possible, avoid the practice of stripping to the waist or wearing shorts to keep cool during the daytime. Select bivouac areas as far from forests as the tactical situation permits.

D. Other Arboviral Fevers. Dengue fever, paragraph IV.B., and Yellow fever, paragraph IV.C., are described in greater detail than the following arboviral diseases because of detailed knowledge of their epidemiologies and potential for producing severe hemorrhagic disease. In general, other arboviral fevers in Bolivia are poorly understood; however, some have the potential for inflicting high morbidity, especially in non-immune personnel. Incapacitation can occur rapidly, lasting a few days to several weeks. Although clinical symptoms differ slightly for each, they generally consist of fever, headache, dizziness, arthralgia, myalgia, often a rash, and occasionally prostration. Other Bolivian arboviruses include the Togaviridae (Alphaviruses): Eastern equine encephalomyelitis (EEE) and Mayaro. Historical data indicate that a broad area of the Departments of Beni and extreme northern Santa Cruz may be at risk from unspecified "equine encephalitis." Mayaro is focally enzootic in the forested lowlands east of the Andes. Outbreaks with attack rates approaching 50% have been reported from the Department of Santa Cruz. The Arboviruses other than dengue and yellow fever that occur in Bolivia, or that may be present east of the Andes in lowland tropical areas geographically contiguous with the Amazon basin, are listed in Appendix A.3 with the profiles of their suspected or proven vectors. Vaccines are not available for these arboviral diseases. Prevention of human cases requires control of mosquitoes, use of repellents (day and night) and bed nets, and avoidance of forest habitats when possible.

Worthy of special mention is Oropouche virus (Bunyaviridae: Bunyavirus), which occurs in the eastern lowlands of the Amazon basin of neighboring Peru and Brazil, and undoubtedly occurs in similar lowland habitats of Bolivia. Oropouche occurs in either a sylvatic (forest) or urban cycle. Little is known about the sylvatic cycle, although primates, sloths, and possibly wild birds are implicated reservoirs. The biting midge, *Culicoides paraensis*, is a proven vector. *Culex quinquefasciatus* is also capable of transmission but considered to be of minor importance. Vector ecology profiles for *C. paraensis* and *Cx. quinquefasciatus* are presented in Appendix A.3. Epidemics involving hundreds of thousands of people have occurred in the Amazon basin of Brazil. Oropouche virus may inflict rapid, extensive, and high morbidity in military personnel. Explosive outbreaks occur in urban areas and rural villages, especially those near banana and cacao crops. U.S. military entomologists in Brazil have noted that the use of insecticides in cacao and banana plantations for other agricultural pests drastically reduce populations of *C. paraensis*. Residual pesticides can be directed at breeding areas at any time, while aerosol applications are applied approximately an hour before sunset, during periods of peak host seeking activity. Maintain good sanitation by eliminating wet and decaying vegetation (e.g., banana tree stalks and stumps, discarded cacao pods) that could provide ample breeding for *Culicoides*. Using extended duration deet repellent and keeping trousers tucked into boots will prevent bites. Avoid laying on the ground during the day, as individuals doing so while in the life zone of *C. paraensis*, are at greater risk of being bitten. Do not camp in or adjacent to banana or cacao plantations.

E. American Trypanosomiasis (Chagas Disease). Chagas disease is the second most important arthropod-borne disease in the country. This disease is caused by *Trypanosoma cruzi*, a flagellated protozoan that is transmitted by infected conenose or kissing bugs of the family Reduviidae. It is an insidious disease with variable symptoms in the acute phase, ranging from none to unilateral facial edema (Romaña's sign) usually at the site of bite(s), fever, malaise, swollen lymph glands, and enlarged liver and spleen. Symptoms generally appear 5-14 days after infection. Chronic symptoms usually involve the heart, intestinal and autonomic nervous systems that persist for many years after the initial infection. Involvement of these organ systems results in extensive lingering morbidity and 20% fatalities. A second protozoan (*Trypanosoma rangeli*) is often present in vector species but has not been linked to human disease. Xenodiagnosis (blood feeding of "clean" bugs on a patient, waiting for several weeks, and examining the bug's feces for trypanosomes) is a method of diagnosis, useful especially during the chronic phase of the disease when the number of trypanosomes in the blood is low. An indirect fluorescent antibody technique is also available for testing blood and spinal fluid for *T. cruzi* antibodies. Trypanosomes present in blood may be transmitted during blood transfusions.

1. Military Impact and Historical Perspective. Chagas disease is associated with poverty, primarily in rural areas, although it has spread to some peri-urban areas as a result of rural populations relocating to urban centers. In 1985, endemic areas included 80% of the country's territory, infected triatomines were found in 7 of the 9 Departments, and serologies indicated 500,000 cases in Cochabamba, Sucre, Tarija, and Santa Cruz Departments. Despite an eradication program started in 1991, transmission continues to occur over 63% of the national territory. It's estimated there are a total of 1.2 million human infections. Since soldiers operate in the forest, it's more likely they will be bitten by extradomiciliary kissing bugs, especially if they do not use **PPM**. In addition, the disease has the potential to infect many troops that bivouac (sleep) adjacent to or in areas with substandard housing (e.g., makeshift and palm thatched construction). Avoiding such areas and using personal protective measures to prevent biting bugs will minimize risk. Because serious symptoms are delayed, the greatest impact will be on the individual soldier and the medical support system subsequent to deployments.

2. Transmission Cycle. Humans are important reservoirs of the parasite, *T. cruzi*, as are many domestic and peridomestic animals (e.g., dogs, cats, guinea pigs, and swine). Hosts differ depending on the locality and vector species of Triatominae, Reduviidae (triatomines, conenose bugs, kissing bugs). Some sylvatic species of triatomines feed on humans who enter their habitats, but they are usually considered important only in maintaining the cycle in nature. When triatomines feed on infected humans, trypanosomes are ingested and begin to replicate in the hindgut. The bug becomes infective 10-30 days after feeding on an infected host and remains so for life (as long as two years). Nymphal triatomines may also acquire trypanosomes while feeding on the infected blood of other engorged bugs. All feeding stages of the bug may become infective. Human infections occur when bugs defecate on the skin of their host during feeding and the infected feces are rubbed into the bite puncture or abrasions, or onto the mucosae of the eyes, mouth, or nose. The most important vectors of Chagas disease live in association with man in domestic or peridomestic settings, inflict nearly painless bites, and defecate on the host. Species with delayed patterns of defecation (e.g., feed and leave before defecating) are incapable of transmitting trypanosomes. Triatomines feed on humans only at night and particularly on the neck and face.

3. Vector Ecology Profile. Vector ecology profiles for the Bolivian species *Triatoma infestans, Triatoma sordida, Triatoma guasayana, Panstrongylus megistus,* and *Rhodnius prolixus* are presented in Appendix A.4.

4. Vector Surveillance and Suppression. Surveillance of triatomines is best conducted with at night with a flashlight. Host-seeking bugs (adults and nymphs) can be detected crawling in the open, particularly around sleeping/bedding areas, guinea pig enclosures, and livestock shelters. Also, check harborages for triatomine bugs, such as cracks and crevices of adobe walls and wood and thatched roofs. Triatomine fecal stains on walls are another sign of infestations. Light traps are ineffective as a surveillance tool for Reduviidae, although some sylvatic species are attracted to light sources. Should chemical control become operationally feasible and necessary, spraying of interior surfaces of walls, cracks and crevices, overhead thatching, rafters, and under bed structures will control bug populations. Deltamethrin has been used successfully for controlling *T. infestans* in domestic and peridomestic situations. Species of Reduviidae that occur in Bolivia appear in Appendix B.3. Risk of contacting vectors is greatest in or near dwellings with abundant cracks and crevices (e.g., thatch, dirt, or makeshift shanty construction) and domestic animal shelters (e.g., livestock, chickens, pigeons, etc.). Sylvatic species are potential biters also. Avoid sleeping near palm trees that may harbor triatomines. During sleep, keep as much of the body covered as possible and use extended-duration deet repellent on exposed skin surfaces. Headnets and bednets used to prevent mosquito/sand fly-borne diseases will also exclude night-feeding triatomines (TIM 36).

F. Epidemic Typhus. The agent of epidemic or louse-borne typhus, *Rickettsia prowazekii*, is transmitted in the feces of infected body lice (*Pediculus humanus humanus*) and not by the bite of the louse. Seven to 14 days post-infection, headache ensues followed by fever, chills, prostration and general body aches. A macular rash usually appears on the upper trunk and spreads to the entire body. Failure to treat with antibiotics may result in 10-40% fatalities.

1. Military Impact and Historical Perspective. The disease is endemic throughout the Andean cordilleras in the Departments of LaPaz, Cochabamba, Oruro, Chuquisaca, and probably Tarija. Historically, most cases occur between March and September. Data are scanty after the late 1970s when the disease was no longer reportable. The potential for outbreaks among the indigenous population would be great during operations involving concentrations of refugees or prisoners of war, but few cases would be expected among soldiers who use routine **PPM**. Delousing refugees, displaced persons and other civilians may be problematic. The Department of Defense no longer has the capability to mass delouse using insecticidal dusts and power-driven application equipment. Current methods of control include oral or topical pediculicides, washing or replacing clothing, and applying repellents. Since the specific methods may not be approved in the U.S., their use during emergencies should be at the discretion of the Joint Task Force Surgeon after consultation with non-governmental organizations (such as the World Health Organization) and host nation officials. Control of body lice must be concurrent with louse-borne disease control.

2. Transmission Cycle. Transmission is confined to the louse-human-louse cycle. Humans are the reservoir of *R. prowazekii* and the sole host for the human body louse, *P. h. humanus*. During the febrile period and for 2-3 days after, lice may acquire *Rickettsia* while feeding. The feces of the louse become infective 2-6 days later. The louse usually dies within two weeks from pathological effects of the *Rickettsia*. During the life of the infective louse, rickettsiae are excreted in the feces while the louse feeds, and the feces (or the crushed louse) are subsequently rubbed into the bite or other abraded areas, infecting the individual. Infection may also occur by inhalation of infected louse feces. Some people suffer a mild form of the disease (Brill's disease) and become asymptomatic carriers, relapsing and introducing the disease into healthy populations many years later.

3. Vector Ecology Profile. Female lice produce 4-5 eggs per day. Eggs adhere to clothing and can characteristically be found in the seams. Eggs are viable for no more than 4 weeks and lice survive for only a few days without a blood meal; therefore clothing discarded for a month or more poses no danger of infestation. Eggs hatch in about 7 days, undergo three molts and become adults in 18 days. Male and female nymphs and adults each feed several times per day. Transfer of lice occurs by direct contact between individuals or by sharing infested clothing. Unsanitary conditions and overcrowding caused by social or cultural events, natural disasters, or conflicts that result in concentrations of refugees or prisoners of war, may result in epidemics. The disease is endemic in cooler climates associated with the inter-Andean cordilleras.

4. Vector Surveillance and Suppression. Surveillance for body lice involves examination of suspected individuals and their clothing. Outbreaks of epidemic typhus are indicative of louse infestations. Soldiers should avoid contact with local populations. Suppression of the disease among soldiers or prisoners of war, involves application of permethrin to BDUs and personal clothing, and maintaining a high level of personal hygiene (frequent bathing and laundering of clothing). The DoD currently relies on good sanitation and the wearing of permethrin-treated uniforms to repel and control body lice on soldiers and prisoners of war.

G. Relapsing Fever (louse-borne). The etiologic agent of louse-borne (epidemic) relapsing fever is *Borrelia recurrentis*, which is transmitted by the human body louse, *Pediculus humanus humanus*. Relapsing fever, as its name implies, is a series of fevers interrupted by afebrile periods. The initial incubation period is 5–15 days, and fevers last for 2-9 days followed by an afebrile period of 2-4 days. The febrile/afebrile sequence may continue for up to 10 cycles. Death occurs in 2-10% of untreated cases.

1. Military Impact and Historical Perspective. This disease is a serious potential hazard among louse-infested populations. Epidemics are common in time of war, famine and other situations where pediculosis is enhanced, as among overcrowded, malnourished populations with poor personal hygiene. Epidemics have been reported in Beni Department.

2. Transmission Cycle. The transmission cycle is similar to that of epidemic typhus. Humans are the reservoir of *B. recurrentis* and the only host for the human body louse, *P. h. humanus*. The louse becomes infective 4-5 days after feeding on an infected human. Ingested spirochetes quickly pass out of the gut and into the hemolymph, where they proliferate. The feces of the louse are not infected with spirochetes and spirochetes do not kill the louse (as rickettsiae do in epidemic typhus), nor are spirochetes transmitted through the bite. Transmission occurs only when infected hemolymph of a crushed louse is rubbed into the bite or other abraded areas. Infective lice remain so for life (20-40 days).

3. Vector Ecology Profile. See epidemic typhus, paragraph IV.F.3.

4. Vector Surveillance and Suppression. See epidemic typhus, paragraph IV.F.4. Few cases, if any, would be expected if precautions outlined under epidemic typhus, paragraph IV.F.4., are followed.

H. Relapsing Fever (tick-borne). The etiologic agents of tick-borne (endemic) relapsing fever are species of *Borrelia* transmitted by soft-bodied ticks in the genus *Ornithodoros*. Strains of *Borrelia* are considered specific for the area and species of host tick. The clinical illness is similar to that of louse-borne relapsing fever, with up to 10 cycles of alternating febrile and afebrile periods. Death occurs in 2-10% of untreated cases.

1. Military Impact and Historical Perspective. Tick-borne relapsing fever was reported in 1994 in several foci (Boyuibe, Camiri, and Gutierrez) in Cordillera province, Santa Cruz Department, by a serological survey among the Guarani Indians and mestizos of those settlements. Military exposure to soft-bodied ticks is unlikely, but isolated cases are possible. Personnel should avoid using potentially tick-infested dwellings of indigenous populations.

2. Transmission Cycle. The vector of relapsing fever is unknown in Bolivia, although the biology of *Ornithodoros boliviensis* would implicate it as a suspected vector. It is the only Bolivian species of *Ornithodoros* recorded east of the Andes that lives in human habitations. In general, ticks and humans are primary reservoirs of species of *Borrelia*. The spirochete invades the hemocoel, salivary glands, coxal glands, and ovaries of the vector within 3-4 days after it has fed on an infected human (or small mammals). While transovarial transmission of the spirochete occurs, infection is maintained mostly between humans and ticks. Once infected, the tick is infective for life. Transmission occurs through the bite of infected ticks or from spirochete-laden coxal fluid that enters through broken or even intact skin.

3. Vector Ecology Profile. *Ornithodoros* ticks lay eggs following a blood meal. The eggs hatch into six-legged larvae and multiple molts occur during development to the adult stage. The ticks live 2-5 years or more. All stages and both sexes of the tick feed at night. *Ornithodoros* ticks feed quickly and return to their hiding places. Larval *Ornithodoros boliviensis* parasitize bats (*Myotis nigricans*) that live in the thatched roofs of dwellings, while the adult ticks live in cracks and crevices of the walls and floors in close association with the inhabitants. Dwellings of the Guarani Indians and mestizos of south central Bolivia are frequently infested with *Ornithodoros* ticks. Such close association with infected ticks would explain the prevalence of relapsing fever among these groups. Species of ticks known to occur in Bolivia and their hosts are listed in Appendix B.4.

4. Vector Surveillance and Suppression. The need for surveillance and suppression is unlikely, but visual inspection of cracks, crevices, thatching, walls and floor spaces, etc. may reveal infestations, particularly in sleeping areas. Residual pesticides applied to infested sites will eliminate ticks (TIM 24). Troops should avoid utilizing indigenous shelters or caves for overnight bivouac sites. Use **PPM** when potential exposure cannot be avoided, particularly at night when *Ornithodoros* ticks feed (TIM 36).

I. Plague. Plague is a zoonotic bacterial disease transmitted by the bite of infected fleas. The etiologic agent is *Yersinia pestis*. Clinical manifestations include three forms: bubonic, septicemic, and pneumonic. Bubonic plague has an incubation period of 1-7 days. At onset, symptoms may include fever, chills, malaise, myalgia, nausea, prostration, sore throat and headache. As the disease progresses, buboes teeming with plague bacilli frequently develop in nodes of the lymphatic system closest to the infected bite. Since most bites occur from the waist down, it is typical for buboes to develop in the inguinal region (90%), but they may also occur in the axillary or neck regions. The septicemic form occurs when bacilli enter the bloodstream, where they quickly disseminate to the lungs and cause pneumonic plague. The pneumonic form is particularly dangerous for the patient and for others who might become infected by aerosol droplet transmission. Such secondary cases develop highly infectious pneumonic plague without buboes or septicemia. Epidemics from pneumonic transmission can develop quickly, especially among healthcare providers and closely associated groups. Untreated bubonic plague has a 50-60% case fatality rate, while septicemic and pneumonic cases are usually fatal if not treated early.

1. Military Impact and Historical Perspective. In Bolivia, plague is endemic in the higher mountainous elevations (1,000-2,000 m) of the Departments of LaPaz, Chuquisaca, Santa Cruz, and Tarija. Specific foci where human cases have been reported include but are not limited to: Apacheta, Apolo, Altos, Alto Machiarapo, Altumcama, Camiri, Choreti, Cruz Pata, Gutierrez, Los Altos, Moreta, Puchawi, Santa Cruz del velle Ameno, and Tigri Rumi. Isolated cases or small outbreaks may occur throughout the year with few seasonal effects, although historically, major outbreaks have occurred during the wet season (December through April). A vaccine is available that affords significant protection against flea-borne but not pneumonic plague. Sporadic cases might be expected during operations conducted among urban populations (cities, small towns, or villages) where known cases have occurred or are occurring. Impact on operations would be minimal with the few cases expected.

2. Transmission Cycle. Plague has two transmission cycles, sylvatic and urban. Sylvatic plague occurs among wild rodents in a rodent-flea cycle. Wild rodents and their fleas usually perpetuate the plague cycle in endemic foci. Some rodents are refractory to the effects of plague, thus maintaining the cycle in nature, while others are susceptible, resulting in epizootics and die-offs. When humans enter the domain of a sylvatic cycle, they become exposed to potentially infected fleas. Such cases are sporadic and focal. Urban plague occurs when domestic rodents come in contact with plague-infected sylvatic rodents and/or their fleas. The urban cycle is maintained primarily between species of *Rattus* and their fleas within the domestic environment. Close association of large human populations and *Rattus* spp. may result in rapid transmission to humans in outbreaks of epidemic proportions. Transmission of the plague bacillus by fleas is species-specific. Not all fleas are competent vectors. *Xenopsylla cheopis* is the principal vector of urban plague worldwide. Its efficiency as a vector can be attributed to the number and structure of proventricular spines and to enzymes produced by the plague bacilli. *Yersinia pestis* in the stomach and proventriculus of *X. cheopis* initiates production of a trypsin-like enzyme and coagulase that causes blood to coagulate and block the proventriculus at ambient temperatures below 27°C. This forces the flea to attempt to clear its digestive tract while its feeding, and in the process, effectively inoculate plague bacilli into the host. At ambient temperatures above 27°C, a fibrinolytic factor is produced by *Y. pestis* that breaks down the clot, virtually eliminating the flea's capacity to transmit plague. Thus, urban plague generally occurs at higher elevations or during cooler seasons. Temperatures do not affect the transmission capacity of sylvatic flea vectors, therefore sylvatic plague may occur at any time of the year.

3. Vector Ecology Profile. The primary vector of urban plague in Bolivia is the cosmopolitan Oriental rat flea, *Xenopsylla cheopis*. The human flea, *Pulex irritans*, is also implicated in urban outbreaks. Although it is biologically an inefficient vector, *P. irritans* has an insatiable feeding preference for *Rattus* spp., *Cavia porcellus* (guinea pigs), domestic animals (swine, dogs and cats) and humans and may be abundant in towns and villages. These attributes contribute to *P. irritans*' potential as a vector. Vector ecology profiles for these fleas are presented in Appendix A.5. Bolivian fleas and their hosts are listed in Appendix B.5.

4. Vector Surveillance and Suppression. Plague surveillance involves trapping rodents, collecting and identifying their fleas, and calculating the average number of fleas per host (flea index). Fleas are recovered from the host either by combing with a toothbrush or by running a stream of compressed CO_2 over the rodent's fur. Flea indices are good indicators of plague transmission potential. For *X. cheopis*, the risk of transmission to humans is usually considered high when the flea index is $\geq$1.0 fleas/host. Human population densities, rodent species and their population densities, and the existence of epizootics are important factors in evaluating and establishing an index that has value in predicting transmission, especially for urban plague. Sylvatic plague surveillance is important for evaluating populations of small mammals

(*Oryzomys, Oligoryzomys, Sciurus*) that may interface with domestic rodents. Principles and surveillance techniques are the same as those for evaluating urban plague.

Serologies of cats and dogs are accurate indicators of the presence of plague in limited urban areas, while serologies of free-roaming wild carnivores are better indicators for large areas. Personnel who work with potentially plague-infected fleas or mammals should be vaccinated. Fleas and tissues from suspected mammal reservoirs or humans may be submitted to the Centers for Disease Control and Prevention, National Center for Infectious Diseases, Division of Vector-Borne Infectious Diseases, P.O. Box 2087, Foothills Campus, Fort Collins, Colorado 80522 for plague analysis. Blood samples are easily collected on Nabuto strips (paper strips), dried, and submitted to a laboratory for testing (TG-103). Pending testing, preserve fleas in 2% saline with one small drop of Tween-80 detergent/liter. Tween-80 breaks the surface tension and fleas drown, preventing potentially infective live fleas from arriving at a testing laboratory.

Plague control is usually not feasible during sylvatic epizootics except when adjacent to urban areas where plague infected sylvatic rodents come in contact and share their fleas with commensal rodents. Urban plague control requires chemical treatment of rodent runs and burrows prior to controlling the rodents with rodenticides (TG 138). Failure to rid rodents of their fleas prior to rodent extermination may increase plague transmission by causing plague-infected fleas to seek new hosts. Carbamates such as carbaryl are effective and relatively safe pesticides for flea control.

Wear permethrin-treated BDUs with trousers tucked into boots to protect against biting fleas (TIM 36). Bivouac away from human habitations, sources of man-made rodent harborage, and agricultural grain harvest areas. Avoid indigenous populations during epidemics. Maintain high levels of sanitation to deprive rodents of food, water, and shelter.

V. Militarily Important Vector-Borne Diseases with Long Incubation Periods (>15 days)

A. Leishmaniasis. Leishmaniasis is a potentially disfiguring and sometimes fatal disease caused by a protozoan parasite in the genus *Leishmania*, which is transmitted by bites of phlebotomine sand flies. All vectors of this disease in the New World are in the genus *Lutzomyia*. The disease may take several forms, characterized as cutaneous leishmaniasis (CL), mucocutaneous leishmaniasis (MCL), or visceral leishmaniasis (VL). Incubation in humans may take as little as 10 days or more than 6 months. Symptoms include ulcerative, non-healing skin lesions (CL), lesions in the mucosal areas of the mouth and/or nose (MCL), and internal pathological manifestations resulting in fever, lymphadenopathy, anemia, enlargement of the liver and spleen, and progressive emaciation and weakness (VL). Untreated, VL usually results in death. *Leishmania braziliensis* and *L. chagasi* have been reported in Bolivia. Although the clinical manifestations are not necessarily indicative of the particular strain/species of parasite, *L. braziliensis* is prone to cause the severe disfiguring MCL or “espundia,” while *L. chagasi* produces life-threatening VL. Entomological or tissue specimens can be submitted to: U.S. Naval Medical Research Institute Detachment, NAMRID/Unit 3800, American Embassy, Lima Peru, or Laboratorio de Parasitologia, Instituto Boliviano de Biologia de Altura (IBBA), Embajada de Francia, Casilla 824, LaPaz, Bolivia, for identification of *Leishmania* species.

1. Military Impact and Historical Perspective. Leishmaniasis is endemic in the Departments of Beni, Cochabamba, LaPaz, Pando, and Santa Cruz in areas below 2,000 m, with increased risk in the forested foothills of the yungas between 1,000-2,000 m. Estimated annual case totals for the country vary from 1,000-4,000 and have been increasing since the late 1980s as populations move into endemic areas. Peak vector densities increase towards the end of the dry season (September/October) and decline as the rainy season progresses. The potential for many cases of leishmaniasis (CL, MCL, and VL) is great in the mountain valleys east of the Andes. Units of American soldiers undergoing jungle training in Panama have experienced attack rates as high as 32%. Although not immediately incapacitating, leishmaniasis would be detrimental because treatment costs are high and require four-weeks of hospitalization. In addition, the scarring that accompanies the cutaneous form of the disease could eventually contribute to poor unit morale. Drug resistant isolates of *L. braziliensis* have been documented. Of most concern are soldiers on night patrols that require frequent starting and stopping. Sitting in place for periods of time, and proceeding through multiple habitats makes one extremely vulnerable to biting sand flies. Keeping as much of the skin covered as possible and using extended-duration deet repellents are crucial preventive measures.

2. Transmission Cycle. New World leishmaniases are primarily zoonoses. Humans become infected when they enter the habitat of the vector and reservoirs. When a sand fly feeds on an infected host, ingested parasites develop and proliferate within the fly as motile promastigotes. The flies become infective 8-20 days after an infected blood meal. At subsequent feedings, the motile promastigotes are injected into the bite, are sequestered by macrophages and become non-motile amastigotes. The amastigotes multiply, eventually rupturing the macrophages and dispersing to infect other macrophages. Hosts may remain infective to feeding sand flies for a few months to several years. Wild canines and domestic dogs are proven and significant reservoirs of *Leishmania chagasi*. Reservoirs of other parasite species may include sylvatic rodents, sloths, canines, and man. Reservoirs in some localities remain unknown. As the list of potential sand fly vectors continues to grow, new species of *Leishmania* are also being discovered. At least 14 species of *Leishmania* have been identified in the Americas. *Leishmania* (*Viannia*) *braziliensis*, *L*. (*Leishmania*) *amazonensis* and *L*. (*L*.) *chagasi* have been documented in Bolivia.

3. Vector Ecology Profile. Some human-biting sand fly species do not transmit *Leishmania* parasites. Important proven vectors in Bolivia identified by the WHO Expert Committee on Control of Leishmaniasis (1990) include *Lutzomyia* (*Lutzomyia*) *longipalpis*, *Lu.* (*Psychodopygus*) *c. carrerai*, *Lu*. (*P*.) *llanosmartinsi*, and *Lu*. (*P*.) *yucumensis*. In addition, Killick-Kendrick (1990) lists *Lu.* (*Nyssomyia*) *flaviscutellata* and *Lu* (*N*.) *umbratilis* as proven vectors of leishmaniasis, and both occur in Bolivia. Vector ecology profiles for species with available data are presented in Appendix A.6. Sand fly species known to harbor various species of *Leishmania* are annotated in the list of Bolivian *Lutzomyia* species, Appendix B.2.

4. Vector Surveillance and Suppression. Sand flies can be collected with mechanical or mouth aspirators, while they rest on interior or exterior walls of dwellings, tree trunks, rock crevices, animal shelters, etc. Collecting with an aspirator using human bait has the advantage of capturing anthropophilic species but is a risky practice in endemic areas and should be performed only under an approved human-use protocol. Sticky paper traps made from bond paper soaked in castor oil can be placed in burrows, rock hollows and other places frequented by sand flies. The flies stick to the oil and can easily be removed, counted, identified, and tested or examined for parasites. Some species of sand fly are readily attracted to light traps and can be successfully trapped in standard CDC light traps with fine mesh collecting bags. Various types of animal-baited traps can also be employed (Disney and Shannon Traps). When establishing semi-permanent or permanent bivouac sites, clear areas to provide a vegetation-free barrier zone of about 50 m between encampments and forested areas. Apply residual pesticides to perimeter vegetation. Since sand flies are weak flyers, these measures will provide an effective barrier between potential sand fly vectors and humans. Apply residual pesticides to walls of buildings or to tents (interior and exterior), particularly in bivouac bedding areas (TIM 36). Implement ULV spray operations during the peak-biting period (dusk and dawn) for quick knockdown of flying sand flies (TIM 24). Wear the BDU with trousers bloused and sleeves rolled down just prior to sunset and after dark, apply extended-duration deet repellent on exposed skin, and use fine mesh bednets when possible (TIM 36).

B. Lyme Disease. The ecology of Lyme disease in Bolivia is poorly understood. It is caused by the spirochete *Borrelia burgdorferi*, which is transmitted by the bite of *Ixodes* ticks. Symptoms vary, but following the bite of an infected tick (usually 3-30 days), there may be an onset of general malaise, fever, fatigue, headache, stiff neck, myalgia, migratory arthralgias, and lymphadenopathy. These may be accompanied by an expanding rash (erythema migrans) located at the site of the bite or elsewhere on the body. Erythema migrans occurs in approximately 60% of the cases. Transient swelling and joint pain, particularly in the large joints, may occur weeks to years after the initial infection, occasionally leading to chronic arthritis. Serious neurological and cardiac abnormalities may appear as a result of chronic infection.

1. Military Impact and Historical Perspective. A 1994 serological assessment in Cordillera province, Santa Cruz Department, indicated 10.8% of the population in three localities (Boyuibe, Camiri, and Gutierrez) were positive for *Borrelia burgdorferi* antibodies. Risk is minimal, with no impact on military operations, although sporadic cases are possible.

2. Transmission Cycle. Knowledge is lacking concerning the ecology of Lyme disease in Bolivia. Proven vectors of *B. burgdorferi* in other areas of the world belong to the *Ixodes ricinus* complex (*I. ricinus, I. persulcatus, I. scapularis* and *I. pacificus*). Species belonging to the *Ixodes ricinus* complex have not been reported in Bolivia.

3. Vector Ecology Profile. Potential tick vectors in Bolivia are unknown. Refer to Appendix B.4 for a listing of ticks that occur in Bolivia.

4. Vector Surveillance and Suppression. Assessment of tick populations for species composition and population densities may be accomplished with tick drags and CO_2 baited traps. The former is made of white flannel cloth (30-40 inches square), either attached to a dowel for dragging or to a pole (as a flag) for waving over the surface of the ground or vegetation. Questing ticks adhere to the flannel surface making collection easy. Simple CO_2 traps can be made with a piece of white material 3-4 feet square (non-flannel) laid on the ground with a block of dry ice placed in the center. Flannel material will impede the movement of ticks toward the dry ice. Place double-stick tape on the sheet 360° around the block of dry ice to entrap ticks as they advance toward the CO_2. Ticks also may be found adhering to the underside of the cloth. Broad area tick control is usually not practical or necessary except where personnel are concentrated (e.g., command posts, permanent bivouac areas, garrisons, etc.). Provide area tick control with formulations of chlorpyrifos in accordance with TIM 24. The best personal defense against ticks is the permethrin-impregnated BDU with trousers tucked into boots. Ticks can penetrate under blousing garters. Use extended-duration deet skin repellent on exposed skin areas, especially on the back of the neck at the hairline. Check for ticks frequently using the buddy system and remove attached ticks immediately. Consult Appendix H for detailed guidelines on tick removal.

VI. Other Diseases of Potential Military Significance

A. Bolivian Hemorrhagic Fever (BHF). Unique to Bolivia, BHF is an acute febrile viral illness caused by the Arenavirus Machupo. Illness develops gradually, with malaise, headache, retro-orbital pain, and sustained fever and sweats, followed by prostration. Treatment is supportive and fatalities occur in 15-30% or more of cases. The disease, similar to hantavirus, is zoonotic among populations of the vesper mouse, *Calomys callosus*. The incubation from infection to onset of symptoms is 7-14 days.

1. Military Impact and Historical Perspective. The first known cases of BHF occurred in 1959 in San Joaquin, Orobayaya, and adjacent villages, Beni Department (1959-1962: 470 cases, 142 deaths). The virus was first isolated from the vesper mouse (*Calomys callosus)* in 1963. A second outbreak occurred in 1971 (details unknown), followed by 9 cases (7 deaths) from July-September 1994 in north central Iténez province (Magdalena, Poponas, and San Juanquin), Beni Department. Cases occur primarily during the dry season (May through September). With limited knowledge of the epidemiology of this newly emerging viral disease, military impact is virtually unknown, although the potential for isolated cases exists in the known endemic region.

2. Transmission Cycle. The zoonotic Machupo virus is maintained in a rodent-rodent cycle. An arthropod vector has not been implicated in transmission. Virus is shed in the saliva and urine of infected *C. callosus*. Inhaling contaminated airborne particles or ingesting food or water contaminated with rodent saliva or excreta produces infection. Infected grain products may also be a source of contamination, primarily to agricultural workers.

3. Rodent Ecology Profile. *Calomys callosus*, similar to the cosmopolitan house mouse (*Mus musculus*), readily enters rural dwellings associated with pastoral savanna grasslands and forest edges. Appropriate ecological settings are elevated areas called “alturas” (ca. 700 m) located between river systems. These are rich agricultural developments in clearings between climax forests above flood level. *Calomys callosus* has not been associated with areas along river systems that are subject to periodic flooding. To date, the geographically restricted focus of the disease does not follow that of the more widely distributed rodent reservoir. The rodent is nocturnal, feeds on vegetation (including seeds), and nests under logs, boards, in clumps of grass, in holes in the ground, and even high above the ground in trees. The involvement of other rodents is largely unknown, although experimentally *Proechimys* and *Oryzomys* develop neutralizing antibodies without overt signs of illness.

4. Rodent Surveillance and Suppression. Implementation of a trapping program to assess populations of *Calomys* and their viral infection rates should be carried out only as an operational necessity, as might occur during long-term occupation of an area. Handling *Calomys* would subject preventive medicine personnel to an extremely dangerous virus (virulence comparable to Hantaan virus or Lassa Fever virus). Should mission requirements necessitate handling of animals, use precautions to protect against hantaviruses (TIM 40). Because of the nocturnal behavior and seed eating habits of *Calomys*, it can be successfully trapped at night using grain baits. Avoid trapping and handling *C. callosus* unless absolutely necessary. Troops should avoid camping in grassy, brushy forest edge areas and should not sleep in or near domestic dwellings or outbuildings in endemic areas. Because of the domestic and peridomestic habits of *Calomys*, extermination is practical with the use of poison baits (TG-138).

B. Hantavirus Pulmonary Syndrome (HPS). Hantavirus is a viral zoonotic disease of rodents. Rodents excrete virus in urine and saliva. The usual route of infection to man is through inhalation of virus-contaminated dust particles, ingestion of virus, or potentially through the bite of an infected rodent. The incubation period is not well established, but usually is about 14 days (3 days to 6 weeks). Symptoms include fever, headache, abdominal, joint and lower back pain and sometimes nausea and vomiting, progressing rapidly to acute respiratory distress (HPS). Death occurs in about 50% of the cases. Human hantaviral disease with HPS was first identified as an epidemic in Argentina (1992-96). Additional outbreaks have occurred in the Four Corners area of the southwestern U.S. (1993), Brazil (1993), Paraguay (1996) and Chile (1997). Two isolates of hantavirus were reported in late 1996 from the rice rat, *Oligoryzomys microtis*, in Bolivia. Although the presence of the virus has been documented in Bolivia, no human cases have been reported. Among South American rodents, hantavirus has been reported in the rice rat, *Oligoryzomys flavescens*, long-tailed pygmy rice rat, *Oligoryzomys longicaudatus*, grass field mouse, *Akodon azarae*, and dark field mouse, *Bolomys obscurus* from Argentina, and from the vesper mouse, *Calomys laucha*, in Paraquay. To date, all South American mammalian reservoirs associated with hantavirus belong to the murid subfamily Sigmodontinae. *Akodon azarae* occurs in extreme southern Bolivia, *C. laucha* in the lowlands of southeastern Bolivia, and *O. microtis* in the eastern lowlands of Bolivia and north into eastern Peru. Risk of cases during military operations is remote, but civic actions in Vietnam frequently required soldiers to handle (move) large quantities of rice. Such operations associated with grain crops (wheat, corn, and rice) in southeastern and southern Bolivia would potentially expose soldiers to hantavirus, if the grains were contaminated by rodent reservoirs. Avoid rodent- infested areas, particularly in savannas or grain-harvest areas. Maintain a high level of sanitation to deprive rodents of food, water, and harborage and control rodents as needed with baits (TG-138).

C. Brucellosis. Brucellosis is caused by an enteric bacterial infection of *Brucella abortus* or *Brucella melitensis*. It is transmitted by ingesting unpasteurized milk or milk products of cattle and goats. The incubation period from time of ingestion until symptoms appear varies from 5 to 60 days. Illness is characterized by headache, weakness, profuse sweating, chills, arthralgia, mental depression, weight loss and generalized aching. Brucellosis is enzootic in local dairy populations. During 1992, 46 human cases (1 death) were reported in the Department of Potosí. Do not eat or drink local milk products that have not been approved by preventive medicine or veterinary personnel.

D. Rabies. Rabies is a zoonotic viral disease transmitted through the saliva of animal bites. It is almost always fatal for humans. Cats, dogs, and bats are the principal reservoirs. Rabies is frequently epizootic among bats, wild canines and other carnivorous mammals. Avoid contact with bats, local dogs, cats, and other animals. Immediate reporting for medical treatment is paramount when bites occur. Units should not adopt animals for mascots.

VII. Noxious/Venomous Animals and Plants of Military Significance

A. Arthropods. Identification keys for medically important arthropods are cited in Appendix G. Insect/arachnid bites and stings can cause allergic reactions, create secondary infections and lower unit morale, in addition to their potential disease implications. U.S. Army trip reports filed by medical personnel (1997) indicate that insect bites and accompanying syndromes were a major complaint among soldiers and medical personnel in the Bolivian Army operating in lowland areas east of the Andes. Mosquitoes, which are major nuisance biters of humans, were discussed previously as disease vectors and are not included in this portion of the text. Consult Appendix B.1. for mosquitoes that occur in Bolivia. Residual insecticides (chlorpyrifos, diazinon) applied to grounds and vegetation prior to encampment will eliminate many arthropod pests. Treat tentage periodically with permethrin and use d-phenothrin or other suitable aerosols within enclosed spaces (TIM 24). Avoid using pallets for tent flooring because they provide harborage for unwanted pests. The dual use of repellents on the skin (deet) and on the clothing (permethrin) (DoD Insect Repellent System) combined with proper wear of the BDU will provide the individual soldier with nearly complete protection from most arthropods (TIM 36). Africanized honey bees, wasps, spiders, centipedes, scorpions, and other stinging/biting arthropods require additional precautions as noted below. When retiring, roll clothing tightly and stretch socks over boot tops to exclude entry of arthropods. Shake clothing and boots briskly before dressing and inspect for unwanted intruders. Foxholes are ideal pit traps for crawling arthropods (scorpions, centipedes, spiders, etc.), and snakes may also fall into them. Dug-in troops should always check foxholes for potentially dangerous animals. Following are the major groups of arthropod pests:

1. Ceratopogonidae (biting midges, no-see-ums, punkies). Some anthropophilic species of Ceratopogonidae (*Culicoides*, *Leptoconops*) are extremely annoying. Their bites may produce systemic allergic reactions as well as local irritation. Because of their small size, they may go unnoticed until an individual receives many bites. Breeding habits differ from species to species. Some breed in tree holes or moist, decaying vegetation, while others favor the edges of streams, swamps, ponds and lakes, where adults lay eggs at the interface of moist soil and water. Development may occur in the water, wet soil, or in wet decomposing vegetation (see *Culicoides paraensis*, Appendix A.3). Massive emergence of adults may occur in some species.

2. Dipterans Causing Myiasis. The human bot fly (family Cuterebridae) and the primary screwworm (family Calliphoridae) are major causes of myiasis in humans throughout South America. The human bot fly (*Dermatobia hominis*), less than one centimeter in length, lays its eggs on other arthropods (usually diurnal blood-feeding dipterans, e.g., mosquitoes, deer flies, etc.). While the arthropod carrier feeds on a human host, the phoretic larva emerges onto the host's skin, penetrates and begins to develop. The larva remains at the site of entry throughout its 3-4 month development, causing an irritating form of cutaneous myiasis. The adult female primary screwworm (*Cochliomyia hominivorax*) deposits numerous eggs in a few minutes on any area of broken skin (even sites as minor as a scratch or the site of a tick bite may be attractive). The eggs hatch in <24 hours and the larvae penetrate, feeding on live tissues. They feed for 3-6 days before pupating, causing significant pain and tissue damage. Females may also lay eggs in the nasal passages of sleeping humans. The larvae may invade the nasal cavities, sinuses, and eustachian tubes, causing severe damage. Human deaths have been reported from nasal infestations of the primary screwworm. Fortunately, screwworm flies do not fly after dark. Use extended-duration deet repellent on all exposed skin surfaces to prevent mosquitoes and other biting arthropods from gaining the contact required for *D. hominis* invasion. To prevent potential infestations of *C. hominivorax*, avoid sleeping during the day without headnets or bednets and keep all cuts, scratches and open sores covered.

3. Lepidoptera (urticating moths/caterpillars). Numerous caterpillars in the tropics have poisonous urticating hairs that may cause serious dermatitis. Outbreaks of urticarial reactions have occurred periodically among military personnel in Panama. Investigations revealed that urticarial hairs of caterpillars had dropped into the local swimming pools, irritating swimmers. Avoid contact with caterpillars regardless of how harmless they might appear. Acute episodes of urticarial dermatitis caused by nocturnal moths of the genus *Hylesia* (Saturniidae) are frequently observed in some regions east of the Andes below 2,800 m. Dermatitis is caused by poisonous abdominal setae of the female moths. Humans seldom contact these moths directly, but are adversely effected by airborne setae. Swarms of moths often invade villages at sunset and fly throughout the night around street or porch lights. The insects loose millions of setae that are carried by air currents, and ultimately are inhaled or land on the skin of unsuspecting people. The moths emerge twice a year. Every 4-5 years an emergence cycle of immense proportions occurs, creating many cases of urticarial dermatitis. Clinically, lesions appear as an urticarial rash, especially on the neck and forearms. The rash remains for approximately a week. Lesions are aggravated by repeated nightly exposure to setae. Scratching or rubbing the rash spreads the setae and exacerbates the condition. Newly exposed personnel are more vulnerable to an adverse reaction than previously "immunized" individuals. Oral antihistamines and steroids, and topical application of Natrium hyposulphite have proven useful.

4. Meloidae (blister beetles). Blister beetles produce cantharidin, a powerful vesicant that can cause blistering when in contact with skin. Blister beetles are attracted to lights around sentry guard posts and frequently drop down soldiers' necks or onto their bare arms causing blisters. Although there are no reports in the literature of such incidents in Bolivia, they are known to occur frequently in Panama. Blisters usually result from rubbing or crushing the insects on the skin. Similar phototrophic behavior and blistering occurs in some species of beetles of the family Staphylinidae.

5. Simuliidae (black flies). Temperate Andean regions are not inhabited by anthropophilic species of black flies, although rivers and streams flowing out of the Andean foothills (toward the coast and toward the eastern lowlands) do produce black fly species that are annoying to humans. All anthropophilic black fly species in South America belong to the genus *Simulium*. Species of *Simulium* occurring in Bolivia are listed in **Appendix B.6**.

6. Siphonaptera (fleas). Fleas bites can be an immense source of discomfort. Sensitivity to flea bites may vary from person to person. The most annoying fleas that commonly occur in Bolivia are *Pulex simulans*, *P. irritans* (human flea), *Ctenocephalides canis* (dog flea), *Ctenocephalides felis felis* (cat flea), *Xenopsylla cheopis* (Oriental rat flea) and *Tunga penetrans* (sand flea, chigoe, jigger). *Pulex simulans* and *P. irritans* are frequently confused. *Xenopsylla cheopis*, the premier vector of plague, normally does not leave its common rodent hosts (*Rattus* spp.) in the domestic setting. Fleas must be controlled with insecticides prior to rodent control operations in such areas. Fleas leaving dead hosts are quite mobile, jumping as much as 12 inches, and readily bite humans. *Xenopsylla cheopis* is most common where humidity is high. Dog and cat fleas are usually found in and about homes where animals roam free. Eggs are laid on the host and drop to the floor/ground, hatch and undergo 3 larval stages. When a dwelling is abandoned, the flea larvae will ultimately pupate and remain in a quiescent state for long periods of time. The vibrations caused by movement of anyone entering such premises will stimulate a mass emergence of hungry adult fleas. Avoid using abandoned dwellings. *Pulex irritans*, although called the human flea, is a parasite of free-roaming domestic swine and is indiscriminate in its choice of hosts. This flea bites voraciously indoors and outdoors and is especially prevalent in domestic settings in higher Andean valleys. Although not encountered often, *T. penetrans* may infest primitive peridomestic settings. It is occasionally associated with lamas and vicuñas (western Bolivia). *Tunga penetrans*' ability to penetrate skin and remain embedded can cause extreme discomfort. Blousing trousers inside boots is essential in providing a barrier, since fleas will crawl under blousing garters.

7. Tabanidae (deer/horse flies). Species belonging to the genera *Chrysops*, *Haematopota* and *Lepiselaga* are important biting pests of man. Species of *Tabanus* are primarily zoophilic, but some may also bite humans. Deer and horse flies breed along rivers, lakes, swamps and other aquatic habitats. Although they are capable of extended flight, they usually remain close to their breeding grounds. Exposure is greatest close to sources of water and in low-lying areas. They inflict painful bites, and some species will bite through tight-fitting clothing such as t-shirts. Anthropophilic species are strictly diurnal and feed in open or forested areas, depending on the species. Skin repellents are deterrents but do not provide complete protection from biting tabanids. Avoid operating in wet swampy areas and other aquatic habitats when possible and keep sleeves rolled down when tabanids are active.

8. Chiggers and Ticks. Chiggers are parasitic larvae of the mite families Trombiculidae and Leuwenhoekiidae. Nymphal and adult stages are non-parasitic. Primary man-biting species include *Eutrombicula alfreddugesi, E. batatas,* and *E. tropica*. Other species of *Eutrombicula* may also be a nuisance but the taxonomic status of species in this genus is currently not well established in the region. Species of *Neotrombicula* may occasionally be involved in human infestations. Humans are accidental dead-end hosts; usual hosts species for *Neotrombicula* capable of biting humans are rodents, birds and reptiles. Chiggers do not burrow into the skin, or take a blood meal, but feed on liquefied tissue. Attached chiggers secrete powerful enzymes that disintegrate host skin cells. Eventually, the host tissue-response forms a feeding tube (stylostome) from which the mite imbibes dissolved tissue fluids. Unlike chiggers, six-legged larval (seed) ticks and eight-legged nymphs of the family Ixodidae (hard ticks) each require a blood meal to molt to the next stage. Ticks penetrate the host with their mouthparts and remain attached for various periods, depending on the species. Consult Appendix I for proper tick removal procedures. Although different species have different host preferences, mammals (small and large) or birds are the most common hosts. Individuals react differently to bites of these two groups of ectoparasites. The intense itching that often accompanies chigger and tick bites may lead to scratching open lesions that are subject to secondary infections. Their bites can become a serious morale problem for individuals, particularly those that are sensitized. The host-questing behavior of chiggers and ixodid ticks is similar. The larvae of both families display a clustering behavior where hundreds congregate on an object (leaf, twig, etc.) in a host questing posture. Potential hosts (man included) may brush against the cluster, becoming infested with hundreds of chiggers or larval seed ticks. Either may quest on vegetation up to several feet in height, but chiggers tend to remain closer to the ground (boot top height or less). These behaviors account for the spotty distribution of infestations, in which some people get badly bitten, while others receive only a few bites or none. Initial chigger infestations usually begin at ankle level. Chiggers have a propensity for attaching to humans under tight-fitting clothing (e.g., boot tops, belt line, bra lines) and areas of thin skin (e.g., behind knees, groin, peritoneal and axillary regions), while ticks are less selective but prefer hairlines. Species of Bolivian ticks and their hosts are listed in Appendix B.4. Use extended-duration deet repellent on exposed skin and ensure BDUs are impregnated with permethrin (TIM 36). Ticks and chiggers will crawl under trouser blousings, avoiding both the clothing and repellent barriers of the BDU. It is essential, therefore, to tuck trousers inside boot tops to maximize the protective barrier.

9. Scorpions. Species of scorpions that occur in Bolivia are listed in Appendix B.7. Although some people may be hypersensitive and suffer significant reactions, most South American scorpions are considered no more toxic than common wasps and bees. Scorpions are most active at night and may crawl into clothing and bedding. See precautions paragraph VII.A. above.

10. Spiders. Brown recluse spiders (*Loxosceles laeta* and *L. rufescens*), black widow spiders (*Latrodectus* spp.), and banana spiders (*Phoneutria boliviensis*), are common poisonous spiders that occur in Bolivia. Banana spiders present the greatest potential for serious spider bites among troops that sleep on the ground. The nocturnal wandering habits of these solitary spiders bring them into frequent contact with people when they crawl into clothing, shoes, bedding, tentage and equipment. Little has been written about *P. boliviensis*, but the Brazilian species *Phoneutria nigriventer* is extremely aggressive and inflicts many serious bites. *Phoneutria* and *Latrodectus* venom is neurotoxic, while *Loxosceles* venom may cause severe necrotic lesions. Other species of spiders are capable of causing painful bites, but reactions generally involve only local pain, itching, and swelling. Prevent spider bites by following the guidelines in paragraph VII.A. above.

11. Centipedes. Centipedes in tropical countries attain considerable size and are capable of inflicting painful bites that cause swelling and local tenderness, but they are not considered dangerous. Their toxicity is comparable to that of a bee sting, although the acute pain is much greater and there is more tissue trauma at the sight of the bite. The width of cheliceral punctures may exceed ¾ of an inch.

12. Bees, Wasps and Hornets. The most significant threat among the Hymenoptera is the Africanized honey bee (AHB), endemic throughout Bolivia. Several behavioral features of AHB make them especially dangerous to military personnel: 1) they are extremely aggressive and defensive of their hive, 2) they swarm and abscond excessively, and 3) they frequently build hives close to the ground in any protected cavity. Operations in wooded areas increase the risk of troops interacting with swarming AHB or their hives, particularly at night when they cannot be seen. If encounters occur, move away as swiftly as possible. Bees are not as aggressive away from the hive and have no method of homing in on an intruder at night. Avoid hives and swarming colonies of honey bees (TIM 34). Wasps and hornets are ever present in most localities and isolated stings can be expected. Bee sting kits should be available for individuals with known hypersensitivity to bee stings.

B. Snakes. The venomous terrestrial snakes of northwestern South America belong to the families Elapidae and Viperidae. Coral snakes, cobras, kraits, mambas, and sea snakes constitute the Elapidae but, of the terrestrial members, only coral snakes (*Leptomicrurus* spp. and *Micrurus* spp.) occur in the Neotropical region. Although extremely toxic, coral snakes' timid, reclusive habits preclude them from being encountered often. Coral snakes will not bite unless handled or carelessly provoked, and their fangs are short, requiring a chewing action that delivers only small quantities of venom. Although they pose little threat, their victims suffer 50% fatalities. Six venomous genera of the family Viperidae are found in northeastern South America: *Bothriechis, Bothriopsis, Bothrops, Crotalus, Lachesis,* and *Porthidium*. These snakes are frequently encountered and their bites may be life threatening. Arboreal or semi-arboreal genera include *Bothriechis* and most species of *Bothriopsis* and *Bothrops*. Arboreal species are especially dangerous because their fangs are very long, they deliver copious amounts of venom, and victims are likely to be bitten on the head, arms and upper trunk areas. *Crotalus, Lachesis*, and *Porthidium* spp. are primarily ground dwellers. During floods, many of the ground-dwelling snakes (poisonous and nonpoisonous) may be concentrated along the high water line, increasing the risk of bites. Viper venom varies in toxicity from species to species. Most deaths are caused by *Bothrops* spp., to which the fer de lance (*B. asper*) and barba amarilla (*B. atrox*) belong. Other extremely dangerous snakes include the bushmaster (*Lachesis muta* spp., rarely encountered because of its preference for nocturnal activity) and the tropical rattlesnake (*Crotalus durissus* spp.), reputedly the most dangerous snake in the Americas. Venomous snakes known to occur in Bolivia are listed in Appendix C, together with distribution data. Currently recognized species follow the systematic scheme of K.R.G. Welch (1994). J. Coborn's book, *The Atlas of Snakes of the World*, is an excellent colored pictorial reference for many of the species that may be encountered. Sources of snake antivenoms are provided in Appendix D.

C. Plants. Plants that cause contact dermatitis are listed in Appendix E, and those that produce systemic toxic symptoms (and even death) when ingested are listed in Apprendix F. The components of each plant species (leaves, seeds, etc.) and chemicals that are considered to cause skin reactions or systemic poisoning are listed next to each species. Plants most important to military personnel are *Toxicodendron* spp. and *Anacardium occidentale* (cashew nut). These are abundant at many CONUS installations often causing skin reactions that require soldiers to be placed "on quarters" or hospitalized. Species of *Toxicodendron* in Bolivia are more toxic than U.S. species (poison ivy or poison oak) and may cause more severe skin reactions in the tropics. The cashew nut is extremely toxic if eaten uncooked, and the resin in the plant and fruit can inflict extensive skin damage. Troops should be taught to recognize these plants and to avoid them.

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Appendix A: Vector Ecology Profiles

Appendix A.1. Vector Ecology Profile: Vectors of Malaria in Bolivia.

VECTOR	GEOGRAPHIC DISTRIBUTION	TRANSMISSION SEASON	LARVAL HABITAT	BITING BEHAVIOR	RESTING BEHAVIOR	FLIGHT RANGE
Anopheles darlingi	Plains of northeastern Bolivia in Beni, Pando and Santa Cruz Departments.	Most prevalent during rainy season (November-March). Populations decrease during the dry season.	Generally a riverine species, but also reported in clear water in streams, ponds, and swamps with algae and floating vegetation. Partial shade. Areas of secondary growth. Water temperatures may vary from 17-33ºC. Requires pH near 7.0.	Exophagic[1] or endophagic[2]. Biting activity peaks 30 minutes after sunset with a smaller peak just before sunrise.	Endophilic[3]. Rests on walls 10 minutes before biting. After feeding, rests on vertical surfaces within 2 m of floor, or on ceilings.	Routinely 200-1,500 m. Maximum: 1.6 km.
Anopheles nuneztovari	East of the Andes in lowland areas of Pando and Beni Departments.	Most abundant during April and May, particularly where *An. darlingi* is absent.	Open marshy areas, and along grassy margins of ponds and lakes. Full sunshine or partial shade. Aquatic vegetation and algae often abundant.	Bites about equally indoors and outdoors. Departs dwellings immediately after feeding. Bites most actively from 2200-2400 hours.	Rests outdoors the first 2 hours after dark, but enters dwellings thereafter. Rests on walls 1 m or less from floor.	Unknown.
Anopheles pseudopunctipennis	High warm Andean valleys throughout the Yungas region of the country.	Populations increase at onset of dry season (May) and continue through September.	Sunny pools left along rivers in the dry season. *Spirogira* (algae) required for larval development. Water temperatures between 18-20ºC, pH 7.5-8.5.	More anthropophilic than zoophilic. Exophagic or endophagic. Bites dusk and dawn.	Prefers upper rafter areas indoors. Negatively phototrophic.	Females: 3-6 km. Males: 400-500 m.
Anopheles marajoara	Secondary vector confined to tropical lowlands in Beni and Santa Cruz Departments below 400 m.	Occurs throughout year, but many records reported during the dry season (May-August) and in November.	Large ground pools, small stream pools, swampy shores of lakes, small road puddles, small ponds, and marshy depressions in swamps. Full sunlight, rarely partial shade. Most sites have muddy bottoms and grassy or herbaceous vegetation. Associated aquatic plants include green algae and water hyacinth (*Ceratophyllum*).	Prefers larger hosts: humans and equines. Biting habits unknown, but in some locations will often enter homes to feed.	Unknown in Bolivia, but exophilic[4] in Panama and Venezuela and endophilic both day and night in Amazonia and other areas of Brazil. Known to rest on interior walls.	Females: 560-1500 m
Anopheles braziliensis	Secondary vector east of the Andes in Beni and Santa Cruz Departments.	Predominantly at end of rainy season through dry season (May-August).	In secondary growth, pastures, and forest clearings. Full sunlight or partial shade. Clear ponds and stagnant swamps with mud bottoms, grassy margins, floatage and/or algae.	Anthropophilic or zoophilic. Exophagic. Maximum activity in evenings and in the middle of the day.	Unknown in Bolivia, but endophilic in Amazonia, Brazil.	Unknown.

[1]Exophagic – bites outdoors. [2]Endophagic – bites indoors. [3]Endophilic – rests indoors. [4]Exophilic – rests outdoors.

Appendix A.2. Vector Ecology Profile: Vectors of Dengue and Yellow Fever in Bolivia.

VECTOR	VIRUS	GEOGRAPHIC DISTRIBUTION	TRANSMISSION SEASON	LARVAL HABITAT	BITING BEHAVIOR	RESTING BEHAVIOR	FLIGHT RANGE
Aedes aegypti	Dengue, Urban Yellow Fever	In urban areas generally below 1,200 m, particularly in the vicinity of Santa Cruz, Santa Cruz Department, and in Tarija Department.	Populations increase at the onset of the rainy season (November) when artificial containers are filled with water and vectors are go indoors.	Artificial containers associated with man, i.e., discarded tires, flower pots, vases, rain gutters, rain barrels, cisterns, etc. Occasionally breeds in leaf axils such as *Agave* sp. and banana palms. Females lay single eggs, 3 larval stadia develop in 9 days (4-7 with ideal temperatures), pupae 1-5 days.	Aggressive human biter. Equally exophagic and endophagic. Biting occurs throughout daylight hours.	Endophilic and exophilic. Rests during hours of darkness.	Usually less than 200 m. Maximum: 2km, especially when breeding areas are scarce.
Haemagogus spegazzinii	Sylvatic Yellow Fever	Mountain rain forests on the eastern slope of the Andes (LaPaz, Beni, Tarija, and Santa Cruz Departments) and lowland tropical rain forests (Pando, Beni, and Santa Cruz Departments).	Throughout the year, peaking in the wet season (November-March).	Tree hole and bamboo internode breeder, intolerant of high relative humidity. Attracted to light. Maximum eggs laid: 81, average: 20/female. Eggs hatch after several weeks; 12-14 days to adult emergence (sometimes 21 days). Species has never been colonized.	Biting activity occurs only during daytime. Peak activity toward mid-day. Abundant in forest canopy, in sunny clearings, or around forest margins.	Prefers upper levels of canopy.	Several hundred meters from breeding areas. 11.5 km reported in Brazil.
Haemagogus janthinomys	Sylvatic Yellow Fever	Mountain rain forests on the eastern slope of the Andes (LaPaz, Beni, Tarija, and Santa Cruz Departments) and lowland tropical rain forests (Pando, Beni, and Santa Cruz Departments).	Present year-round, but populations peak during the wet season (November - March) and decline during drier spells.	Breeds in tree holes and bamboo stumps. The gonotrophic cycle lasts about 10 days. Females may live as long as 95 days (average 2 weeks). Over 75% of the eggs are laid between 1200-1600 hours; no eggs laid at night. Most eggs are laid during rainy periods.	Little biting activity outside 1200-1400 hours. Will leave canopy to bite at ground level, especially in damaged forest and along forest edges. Reported to follow people 200-300 m beyond forest edge.	Canopy mosquito.	Unknown, but thought to be very limited.
Haemagogus leucocelaenus (Unless stated otherwise, biological data is based on Trinidad studies)	Sylvatic Yellow Fever	Mountain rain forests on the eastern slope of the Andes (LaPaz, Beni, Tarija, and Santa Cruz Departments) and lowland tropical rain forests (Pando, Beni, and Santa Cruz Departments).	Peak populations follow 4-6 weeks after the start of the rainy season.	Breeds in tree holes. Females oviposit from 1000-1600 hours during the dry season and from 1200-1400 hours during the wet season. Most eggs are laid during the rainy season.	41% of specimens captured at ground level (Panama). Active only during the daytime from sunrise to sunset. Peak activity between 1000-1400 hours. More efficient vector than *Ae. aegypti*.	Found at lower levels than other *Haemagogus* spp.	Unknown.
Sabethes chloropterus	Sylvatic Yellow Fever	Mountain rain forests on the eastern slope of the Andes (LaPaz, Beni, Tarija, and Santa Cruz Departments) and lowland tropical rain forests (Pando, Beni, and Santa Cruz Departments).	Adults in forest throughout the year, most prevalent during rainy season (November - March). Adults are found through the dry season when species of *Haemagogus* are absent.	Tree hole breeders, with preference for large cavities with small openings that hold water throughout dry season. Survey for eggs with bamboo traps (tops closed with small hole through the side). Populations decline in dry season.	Aggressive human biter. 10% of the specimens in a Panama study were collected at ground level using human bait. Daytime biter.	Canopy mosquito.	Unknown.

Appendix A.3. Vector Ecology Profile: Vectors of Arboviruses Other Than Dengue or Yellow Fever in the Amazon Basin and Associated Northwestern Regions of South America.

The geographic distribution of vectors is given in broad terms and a vector may occur in only part of the country mentioned. Furthermore, the distribution given does not imply that any species is a vector over the whole of its range. Country names in parentheses after the arbovirus name indicate that the virus was isolated in that country from the vector listed in the same row of the table. "Geographic Distribution" indicates the countries in which the vector has been found, but does not necessarily indicate the distribution of the arbovirus.

VECTOR	ARBOVIRUS	ARBOVIRUS RESERVOIR	GEOGRAPHIC DISTRIBUTION	TRANSMISSION SEASON	LARVAL HABITAT	BITING BEHAVIOR	RESTING BEHAVIOR	FLIGHT RANGE
Aedes arborealis	Apeu (Brazil)	Marsupials (*Caluromys philander).*	Brazil, French Guiana, and Suriname.	During rainy season (November to March) in tropical rain forests.	Treeholes.	Known to bite humans.	Unknown.	Unknown.
Aedes hastatus	Western Equine Encephalitis (WEE) (Ecuador)	Epizootic transmission undefined, but passerine birds considered important reservoirs.	Argentina, Bolivia, Brazil, Colombia, Costa Rica, Ecuador, French Guiana, Honduras, Mexico, Panama, and Peru.	Unknown.	Temporary ground pools.	Bites humans by day in the forest.	Unknown.	Unknown.
Aedes scapularis	Venezuelan Equine Encephalitis (VEE) (Ecuador, Peru)	VEE: Many mammals and birds, but equines are key reservoirs with high viremias.	Argentina, Bolivia, Colombia, Cuba, Dominican Republic, Ecuador, French Guiana, Guyana, Haiti, Jamaica, Mexico, Panama, Paraguay, Peru, Puerto Rico, Suriname, Trinidad, United States, and Venezuela.	VEE virus activity begins at the end of the rainy season and disappears when the dry season is underway.	Temporary ground pools.	Feeds on birds and large mammals but prefers mammals. A vicious biter of humans, it feeds night or day in a wide variety of locations. It commonly moves indoors in areas that have been populated for long periods.	Unknown.	In one study, observed to move at least 4 km in 11 days.
Aedes septemstriatus	Apeu (Brazil)	Marsupials (*Caluromys philander).*	Brazil, Colombia, Costa Rica, Nicaragua, and Panama.	During the rainy season (November to March) in tropical rain forests.	Treeholes and broken bamboo.	Bites humans by day in the forest.	Unknown.	Unknown.
Aedes serratus	Oropouche	Primates (*Cebus*, *Alouatta*, *Saimiri*, *Saguinus*), sloths.	Argentina, Belize, Bolivia, Brazil, Colombia, Costa Rica, Ecuador, French Guiana, Guadaloupe, Guatemala, Guyana, Honduras, Jamaica, Mexico, Nicaragua, Panama, Peru, Puerto Rico, Suriname, Trinidad, and Venezuela.	Epidemics occur during the rainy season (November to March).	Temporary ground pools.	Bites humans by day in the forest, but prefers to bite at night in open areas. Prefers ground level and often enters buildings. Will also feed on chickens.	Unknown.	Unknown.

Appendix A.3. (Cont'd)

VECTOR	ARBOVIRUS	ARBOVIRUS RESERVOIR	GEOGRAPHIC DISTRIBUTION	TRANSMISSION SEASON	LARVAL HABITAT	BITING BEHAVIOR	RESTING BEHAVIOR	FLIGHT RANGE
Aedes taeniorhynchus	Oriboca VEE (Ecuador, Peru)	Oriboca: *Oryzomys capito*, *Proechimys guyanensis*, *Didelphis marsupialis*. VEE: Many mammals and birds, but equines are key reservoirs with high viremias.	Antigua, Bahamas, Belize, Brazil, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, French Guiana, Guatemala, Guyana, Haiti, Jamaica, Mexico, Nicaragua, Panama, Peru, Puerto Rico, Suriname, St. Lucia, Trinidad, United States, and Venezuela.	Oriboca transmission occurs during the rainy season in tropical rain forests (November to March). VEE virus activity begins at the end of the rainy season and disappears during the dry season.	Coastal salt marshes and mangrove swamps.	Vicious biter of humans by day and night in many kinds of habitats; most active at dawn and dusk.	Rests in vegetation, emerging to bite when disturbed.	Flies up to 32 km.
Anopheles albitarsis Group	WEE (Ecuador)	Epizootic transmission undefined, but passerine birds considered important reservoirs.	Argentina, Bolivia, Brazil, Colombia, Costa Rica, Ecuador, French Guiana, Guatemala, Guyana, Panama, Paraguay, Suriname, Trinidad, Uruguay, and Venezuela.	Unknown.	Ground pools, pools along streams, swamps, and lakes all in full sunlight. Water with grassy margins.	Feeds on large mammals and refuses to feed on birds.	Unknown.	Unknown.
Coquillettidia arribalzagai	Oriboca	*Oryzomys capito*, *Proechimys guyanensis*, *Didelphis marsupialis*.	Brazil, Colombia, French Guiana, Nicaragua, Panama, Peru, and Suriname.	During the rainy season in tropical rain forests.	Larvae attach to roots of aquatic plants in permanent water.	Bites humans by day in forest.	Unknown.	Unknown.
Coquillettidia venezuelensis	Murutucu Oriboca Oropouche	Murutucu: *Oryzomys capito*, *Proechimys guyanensis*, *Nectomys squimipes*, *Didelphis marsupialis*, *Marmosa cinerea*, *Bradypus tridactylus*, *Artibeus literatus*, *Artibeus jamaicensis*. Oriboca: *Oryzomys capito*, *Proechimys guyanensis*, *Didelphis marsupialis*. Oropouche: Primates (*Cebus*, *Alouatta*, *Saimiri*, *Saguinus*), sloths (*Bradypus*), *Zygodontomys*, and possibly wild birds.	Argentina, Belize, Brazil, Colombia, Costa Rica, El Salvador, French Guiana, Guatemala, Guyana, Mexico, Nicaragua, Panama, Peru, Suriname, Trinidad, and Uruguay.	Murutucu and Oriboca transmission occur during the rainy season in tropical rain forests (November to March). Oropouche epidemics occur during the rainy season (November to March).	Larvae attach to roots of aquatic plants in permanent water pools.	Bites humans in the forest, especially where there is secondary growth.	Unknown.	Unknown.

Appendix A.3. (Cont'd)

VECTOR	ARBOVIRUS	ARBOVIRUS RESERVOIR	GEOGRAPHIC DISTRIBUTION	TRANSMISSION SEASON	LARVAL HABITAT	BITING BEHAVIOR	RESTING BEHAVIOR	FLIGHT RANGE
Culex coronator	Caraparu (Brazil, Panama)	*Oryzomys capito*, *Oryzomys laticeps*, *Proechimys guyanensis*, *Nectomys squamipes*, *Zygodontomys brevicauda*, *Heteromys anomalus*.	Argentina, Belize, Brazil, Bolivia, Colombia, French Guiana, Guatemala, Honduras, El Salvador, Mexico, Panama, Paraguay, Peru, Suriname, Trinidad, United States, and Venezuela.	During the rainy season (November to March) in tropical rain forests.	Ground pools, seeps, streams, artificial containers, bromeliads, and bamboo. Stagnant and slow-flowing water, shaded or unshaded.	Commonly considered not to feed on humans, but observed to be a major human biter in the Amazon Basin.	Unknown.	Unknown.
Culex gnomatus	VEE (Ecuador, Peru)	Many mammals and birds, but equines are key reservoirs with high viremias.	Brazil, Ecuador, and Peru.	VEE virus activity begins at the end of the rainy season and disappears during the dry season.	Unknown.	Unknown.	Unknown.	Unknown.
Culex nigripalpus	Caraparu (Brazil, Panama) EEE (Peru) St. Louis Encephalitis (SLE) (Colombia, Ecuador, Guatemala, Jamaica, Trinidad) Vesicular Stomatitis	Caraparu: *Oryzomys capito*, *Oryzomys laticeps*, *Proechimys guyanensis*, *Nectomys squamipes*, *Zygodontomys brevicauda*, *Heteromys anomalus*. EEE: Birds, particularly passerines. SLE: Wild birds. Vesicular Stomatitis: Poorly understood but primarily a disease of livestock (bovines and equines).	Bahamas, Barbados, Belize, Brazil, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, French Guiana, Guatemala, Guyana, Jamaica, Mexico, Panama, Puerto Rico, Suriname, Trinidad, United States, and Venezuela.	Caraparu transmission occurs during the rainy season (November to March) in tropical rain forests. EEE virus activity occurs throughout the year (Peru). SLE: unknown.	Wide variety of habitats, including ground pools, ditches, grassy pools, crab holes, permanent pools in swamps, artificial containers, beaches, boats, and axils of bromeliads.	Feeds on humans, sometimes entering houses or tents.	Unknown.	Unknown.

Appendix A.3. (Cont'd)

VECTOR	ARBOVIRUS	ARBOVIRUS RESERVOIR	GEOGRAPHIC DISTRIBUTION	TRANSMISSION SEASON	LARVAL HABITAT	BITING BEHAVIOR	RESTING BEHAVIOR	FLIGHT RANGE
Culex ocossa	VEE (Ecuador, Peru) Apeu (Brazil) Caraparu (Brazil, Panama) Itaqui (Brazil, Venezuela) Marituba (Peru) Murutucu Oriboca	Apeu: Marsupials (*Caluromys philander*). Caraparu: *Oryzomys capito*, *Oryzomys laticeps*, *Proechimys guyanensis*, *Nectomys squamipes*, *Zygodontomys brevicauda*, *Heteromys anomalus*. Itaqui: *Oryzomys capito*, *Proechimys guyanensis*, *Nectomys squamipes*, *Marmosa murina*, *Metachirus nudicaudatus*. Marituba: Marsupials (*Didelphis marsupialis*). Murutucu: *Oryzomys capito*, *Proechimys guyanensis*, *Nectomys squamipes*, *Didelphis marsupialis*, *Marmosa cinerea*, *Bradypus tridactylus*, *Artibeus literatus*, *Artibeus jamaicensis*. Oriboca: *Oryzomys capito*, *Proechimys guyanensis*, *Didelphis marsupialis*.	Argentina, Brazil, Colombia, Ecuador, Guyana, Panama, Suriname, and Venezuela.	VEE virus activity begins at the end of the rainy season and disappears when the dry season is underway. Apeu, Caraparu, Itaqui, Marituba, Murutuca and Oriboca transmission occur during the rainy season (November to March) in tropical rain forests.	Permanent pools, always associated with aquatic plants such as *Pistia*.	Endophagic.	Commonly rests on screens of windows.	Unknown.
Culex pedroi	EEE (Peru)	Birds, particularly passerines.	Argentina, Brazil, Colombia, Costa Rica, Ecuador, French Guiana, Guatemala, Guyana, Mexico, Panama, Peru, Suriname, Tobago and Trinidad.	Virus activity occurs throughout the year (Peru).	Heavy shade in permanent bodies of water with abundant floatage.	Commonly bites humans but apparently prefers rodents. Has been known to feed on birds.	Unknown.	Unknown.

Appendix A.3. (Cont'd)

VECTOR	ARBOVIRUS	ARBOVIRUS RESERVOIR	GEOGRAPHIC DISTRIBUTION	TRANSMISSION SEASON	LARVAL HABITAT	BITING BEHAVIOR	RESTING BEHAVIOR	FLIGHT RANGE
Culex portesi	Bimiti (Peru) Guama (Guama, Colombia) Itaqui (Brazil, Venezuela) Marituba (Peru) Murutucu Oriboca	Bimiti: *Oryzomys laticeps, Zygodontomys brevicauda, Heteromys anomalus, Proechimys guyanensis.* Guama: *Oryzomys capito, Proechimys guyanensis, Nectomys squamipes, Oryzomys laticeps, Heteromys anomalus, Zygodontomys brevicauda, Coendou* spp. Itaqui: *Oryzomys capito, Proechimys guyanensis, Nectomys squamipes, Marmosa murina, Metachirus nudicaudatus.* Marituba: Marsupials (*Didelphis marsupialis*). Murutucu: *Oryzomys capito, Proechimys guyanensis, Nectomys squamipes, Didelphis marsupialis, Marmosa cinerea, Bradypus tridactylus, Artibeus literatus, Artibeus jamaicensis.* Oriboca: *Oryzomys capito, Proechimys guyanensis, Didelphis marsupialis.*	Brazil, Colombia, French Guiana, Peru, Suriname, Trinidad, and Venezuela.	Bimiti virus activity begins at the end of the rainy season (March) and disappears during the dry season (May). Guama transmission occurs during the rainy season in tropical rain forests (November to March). Incubation period <10 days. Itaqui, Marituba, Murutucu and Oriboca transmission occurs during the rainy season (Novembers to March) in tropical rain forests.	Lowland swamp forests at elevations from sea level to 30 m. Larvae also found in deep shade of tree buttresses, root caves, and leafy swamp margins.	Unknown.	Unknown.	Unknown.
Culex quinquefasciatus	Oropouche	Primates (*Cebus, Alouatta, Saimiri, Saguinus*), sloths.	Associated with human settlements and widely distributed throughout the tropical and subtropical regions of the world.	Year-round where temperatures are favorable for mosquito development, but especially during the dry season when organic material concentrates in breeding areas.	Stagnant/ polluted water high in organic content, in ground seeps or in artificial containers. Breeds in clean and brackish water.	Preference for avian blood but will feed readily on mammals, including humans. Bites throughout night, but especially a few hours before and after midnight.	Rests during day in dark humid shelters, e.g., culverts, cellars, outhouses, chicken houses.	Routinely 200-300 m. Maximum: 1.3 km, but Hawaiian studies show that 4 km is common.

Appendix A.3. (Cont'd)

VECTOR	ARBOVIRUS	ARBOVIRUS RESERVOIR	GEOGRAPHIC DISTRIBUTION	TRANSMISSION SEASON	LARVAL HABITAT	BITING BEHAVIOR	RESTING BEHAVIOR	FLIGHT RANGE
Culex spissipes	Bimiti (Peru) Caraparu (Brazil, Panama) Itaqui (Brazil, Venezuela) Oriboca	Bimiti: *Oryzomys laticeps*, *Zygodontomys brevicauda*, *Heteromys anomalus*, *Proechimys guyanensis.* Caraparu: *Oryzomys capito*, *Oryzomys laticeps*, *Proechimys guyanensis*, *Nectomys squamipes*, *Zygodontomys brevicauda*, *Heteromys anomalus*. Itaqui: *Oryzomys capito*, *Proechimys guyanensis*, *Nectomys squamipes*, *Marmosa murina*, *Metachirus nudicaudatus*. Oriboca: *Oryzomys capito*, *Proechimys guyanensis*, *Didelphis marsupialis*.	Belize, Bolivia, Brazil, Colombia, Ecuador, French Guiana, Guatemala, Honduras, Mexico, Panama, Peru, Suriname, Trinidad, and Venezuela.	Bimiti virus activity begins at the end of the rainy season (March) and disappears during the dry season (May). Caraparu, Itaqui and Oriboca transmission occur during the rainy season (November to March) in tropical rain forests.	Heavily or partially shaded margins of lakes in forests, margins of swamps, and in ground pools. Water is usually permanent and fresh, with abundant grassy and floating aquatic vegetation, or with dense accumulations of fallen leaves.	Has been collected at night in mouse-baited traps.	Unknown.	Unknown.
Culex taeniopus	Bimiti (Peru) Guama (Colombia, Peru) Ossa (Panama)	Bimiti: *Oryzomys laticeps*, *Zygodontomys brevicauda*, *Heteromys anomalus*, *Proechimys guyanensis.* Guama: *Oryzomys capito*, *Proechimys guyanensis*, *Nectomys squamipes*, *Oryzomys laticeps*, *Heteromys anomalus*, *Zygodontomys brevicauda*, *Coendou* spp. Ossa: *Proechimys semispinosus.*	Bahamas, Belize, Cayman Islands, Colombia, Costa Rica, Dominican Republic, French Guiana, Guatemala, Honduras, Jamaica, Mexico, Nicaragua, Panama, Puerto Rico, and Venezuela.	Bimiti virus activity begins at the end of the rainy season (March) and disappears when dry season is underway (May). Guama transmission occurs during the rainy season in tropical rain forests (November to March). Incubation period <10 days. Ossa transmission occurs during the rainy season in tropical rain forests (November to March).	Found in stagnant water in swamps and forests.	Unknown.	Unknown.	Unknown.

Appendix A.3. (Cont'd)

VECTOR	ARBOVIRUS	ARBOVIRUS RESERVOIR	GEOGRAPHIC DISTRIBUTION	TRANSMISSION SEASON	LARVAL HABITAT	BITING BEHAVIOR	RESTING BEHAVIOR	FLIGHT RANGE
Culex vomerifer	Caraparu (Brazil, Panama) Guama (Colombia, Peru) Itaqui (Brazil, Venezuela) Murutucu Ossa (Panama)	Caraparu: *Oryzomys capito*, *Oryzomys laticeps*, *Proechimys guyanensis*, *Nectomys squamipes*, *Zygodontomys brevicauda*, *Heteromys anomalus*. Guama: *Oryzomys capito*, *Proechimys guyanensis*, *Nectomys squamipes*, *Oryzomys laticeps*, *Heteromys anomalus*, *Zygodontomys brevicauda*, *Coendou* spp. Itaqui: *Oryzomys capito*, *Proechimys guyanensis*, *Nectomys squamipes*, *Marmosa murina*, *Metachirus nudicaudatus*. Murutucu: *Oryzomys capito*, *Proechimys guyanensis*, *Nectomys squamipes*, *Didelphis marsupialis*, *Marmosa cinerea*, *Bradypus tridactylus*, *Artibeus literatus*, *Artibeus jamaicensis*. Ossa: *Proechimys semispinosus*.	Brazil, Colombia, Ecuador, French Guiana, Panama, Peru, Trinidad, and Venezuela.	Caraparu transmission occurs during the rainy season (November to March) in tropical rain forests. Guama transmission occurs during the rainy season in tropical rain forests (November to March). Incubation period <10 days. Itaqui, Murutucu and Ossa transmission occur during the rainy season (November to March) in tropical rain forests.	Treeholes, most often found in the forest canopy.	Unknown	Unknown	Unknown
Culex (*Melanoconion)* spp.	SLE (Ecuador) VEE (Ecuador, Peru)	SLE: Wild birds. VEE: Many mammals and birds, but equines are key reservoirs with high viremias.	Unknown.	SLE: Unknown. VEE: Virus activity begins at the end of the rainy season and disappears during the dry season.	Unknown.	Unknown.	Unknown.	Unknown.

Appendix A.3. (Cont'd)

VECTOR	ARBOVIRUS	ARBOVIRUS RESERVOIR	GEOGRAPHIC DISTRIBUTION	TRANSMISSION SEASON	LARVAL HABITAT	BITING BEHAVIOR	RESTING BEHAVIOR	FLIGHT RANGE
Haemagogus janthinomys	Mayaro (Bolivia, Colombia, Peru)	Callithricid primates (*Callithrix argentata* and *Callithrix humeralifer*) and passerine birds.	Argentina, Bolivia, Brazil, Colombia, Costa Rica, Ecuador, French Guiana, Guyana, Honduras, Nicaragua, Panama, Paraguay, Peru, Suriname, Tobago and Trinidad, and Venezuela.	Disease found mainly in forests.	Treeholes, most often found in the forest canopy.	Bites humans during the day in the canopy of undisturbed rain forest.	Unknown.	Unknown.
Limatus durhamii	Caraparu (Brazil, Panama)	*Oryzomys capito*, *Oryzomys laticeps*, *Proechimys guyanensis*, *Nectomys squamipes*, *Zygodontomys brevicauda*, *Heteromys anomalus*.	Argentina, Belize, Bolivia, Brazil, Costa Rica, Dominican Republic, Ecuador, El Salvador, French Guiana, Guadaloupe, Grenada, Guyana, Honduras, Mexico, Nicaragua, Panama, Peru, Suriname, Trinidad, and Venezuela.	During the rainy season (November to March) in tropical rain forests.	Fallen leaves and small containers with abundant decomposing plant matter.	Bites humans in disturbed forests during the day.	Unknown.	Unknown.
Limatus flavisetosus	Mayaro (Bolivia, Colombia, Peru) Wyeomyia (Colombia)	Callithricid primates (*Callithrix argentata* and *Callithrix humeralifer*) and passerine birds. *Wyeomyia*: "Mosquito."	Bolivia, Brazil, Colombia, French Guiana, Peru, and Suriname.	Disease found mainly in forests. *Wyeomyia*: Unknown.	Fallen leaves and small containers with abundant decomposed plant matter.	Bites humans mainly during the day at ground level in the forest.	Unknown.	Unknown.
Limatus spp.	Guama	*Oryzomys capito*, *Proechimys guyanensis*, *Nectomys squamipes*, *Oryzomys laticeps*, *Heteromys anomalus*, *Zygodontomys brevicauda*, *Coendou* spp.	Colombia, Peru.	During the rainy season in tropical rain forests (November to March). Incubation period <10 days.	Unknown.	Unknown.	Unknown.	Unknown.
Mansonia indubitans (Ecuador)	Vesicular Stomatitis	Poorly understood but primarily a disease of livestock (bovines and equines).	Bolivia, Brazil, Ecuador, Panama, Peru, Trinidad, and Uruguay.	Virus activity begins at the end of the rainy season and disappears when the dry season is underway.	Permanent water with abundant vegetation. Larvae use siphon to penetrate roots of aquatic plants for air.	Bites humans day or night, sometimes indoors. Vicious biter.	Unknown.	Unknown.

Appendix A.3. (Cont'd)

VECTOR	ARBOVIRUS	ARBOVIRUS RESERVOIR	GEOGRAPHIC DISTRIBUTION	TRANSMISSION SEASON	LARVAL HABITAT	BITING BEHAVIOR	RESTING BEHAVIOR	FLIGHT RANGE
Mansonia spp.	Guama (Colombia, Peru) WEE (Ecuador)	Guama: *Oryzomys capito*, *Proechimys guyanensis*, *Nectomys squamipes*, *Oryzomys laticeps*, *Heteromys anomalus*, *Zygodontomys brevicauda*, *Coendou* spp. WEE: Epizootic transmission undefined, but passerine birds considered important reservoirs.	Guama: Colombia, Ecuador, Peru. WEE: Ecuador, Peru.	Guama: During the rainy season in tropical rain forests (November to March). Incubation period <10 days. WEE: unknown.	Unknown.	Unknown.	Unknown.	Unknown.
Psorophora albigenu	EEE (Peru) VEE (Peru)	EEE: Birds, particularly passerines. VEE: Many mammals and birds, but equines are key reservoirs with high viremias.	Argentina, Bolivia, Brazil, Ecuador, Paraguay, Peru, and Venezuela.	EEE virus activity throughout the year (Peru). VEE virus activity begins at the end of the rainy season and disappears when the dry season is underway.	Heavily shaded temporary ground pools.	Unknown.	Unknown.	Unknown.
Psorophora albipes (Colombia)	Mayaro (Bolivia, Colombia, Peru)	Callithricid primates (*Callithrix argentata* and *Callithrix humeralifer*) and passerine birds.	Bolivia, Brazil, Guatemala, Colombia, Honduras, Mexico, Peru, Suriname, Trinidad, and Venezuela.	Disease found mainly in forests.	Temporary ground pools.	Bites humans primarily during the day in the forest. Can be the dominant biting species.	Unknown.	Unknown.
Psorophora ferox	EEE (Peru) Ilheus (Colombia) Mayaro (Bolivia, Colombia, Peru) Oriboca	EEE: Birds, particularly passerines. Ilheus: Unknown. Mayaro: Callithricid primates (*Callithrix argentata* and *Callithrix humeralifer*) and passerine birds. Oriboca: *Oryzomys capito*, *Proechimys guyanensis*, *Didelphis marsupialis*.	Canada south to Argentina.	EEE Virus activity throughout the year (Peru). Ilheus: Unknown. Mayaro transmission occurs mainly in forests. Oriboca transmission occurs during the rainy season in tropical rain forests.	Temporary, shaded ground pools in forests.	Bites humans at ground level, usually in the forest during the day. A vicious biter of any warm-blooded animal, waits in vegetation and emerges to bite. Sometimes bites indoors.	Unknown.	Usually remains near larval site but has been observed to fly up to 2 km.

Appendix A.3. (Cont'd)

VECTOR	ARBOVIRUS	ARBOVIRUS RESERVOIR	GEOGRAPHIC DISTRIBUTION	TRANSMISSION SEASON	LARVAL HABITAT	BITING BEHAVIOR	RESTING BEHAVIOR	FLIGHT RANGE
Psorophora pallescens	WEE (Ecuador)	Epizootic transmission undefined, but passerine birds considered important reservoirs.	Argentina, Bolivia, Ecuador and Paraguay.	Unknown.	Predacious on other mosquito larvae in temporary ground pools.	Has been observed to feed primarily on cattle, but also other large mammals and on chickens.	Unknown.	Unknown.
Psorophora spp.	Guama (Colombia, Peru)	*Oryzomys capito*, *Proechimys guyanensis*, *Nectomys squamipes*, *Oryzomys laticeps*, *Heteromys anomalus*, *Zygodontomys brevicauda*, *Coendou* spp.	Colombia and Peru.	During the rainy season in tropical rain forests (November to March). Incubation period <10 days.	Unknown.	Unknown.	Unknown.	Unknown.
Trichoprosopon digitatum	Bussuquara (Panama) SLE (Colombia, Ecuador) Wyeomyia (Colombia)	Bussuquara and Wyeomyia: "Mosquito". SLE: Wild birds.	Belize, Brazil, Colombia, Costa Rica, Ecuador, French Guiana, Guatemala, Guyana, Mexico, Nicaragua, Panama, Peru, Suriname, and Venezuela.	Unknown.	Bamboo internodes, fallen fruits or nuts, fallen leaves, artificial containers (cans, tires, dishes, etc.), treeholes, *Heliconia* flower bracts, and leaf axils of bromeliads.	Bites humans, especially at ground level in the forest during the day, with greatest numbers in the evening. A vicious biter.	Unknown.	Unknown.
Trichoprosopon spp.	Guama (Colombia, Peru)	*Oryzomys capito*, *Proechimys guyanensis*, *Nectomys squamipes*, *Oryzomys laticeps*, *Heteromys anomalus*, *Zygodontomys brevicauda*, *Coendou* spp.	Colombia, Peru	During the rainy season in tropical rain forests (November to March). Incubation period <10 days.	Unknown.	Unknown.	Unknown.	Unknown.

Appendix A.3. (Cont'd)

VECTOR	ARBOVIRUS	ARBOVIRUS RESERVOIR	GEOGRAPHIC DISTRIBUTION	TRANSMISSION SEASON	LARVAL HABITAT	BITING BEHAVIOR	RESTING BEHAVIOR	FLIGHT RANGE
Wyeomyia aporonoma	Mayaro (Bolivia, Colombia, Peru) Wyeomyia (Colombia)	Mayaro: Callithricid primates (*Callithrix argentata* and *Callithrix humeralifer*) and passerine birds. Wyeomyia: "Mosquito."	Belize, Bolivia, Brazil, Colombia, Costa Rica, El Salvador, French Guiana, Grenada, Guatemala, Guyana, Honduras, Mexico, Panama, St. Vincent, and Venezuela.	Mayaro transmission is suspected to occur year-round, mainly in forests. Wyeomyia: unknown.	Leaf axils of terrestrial bromeliads.	Bites humans in the forest during the day in the canopy or at ground level.	Unknown.	Unknown.
Wyeomyia medioalbipes	Caraparu (Brazil, Panama) Wyeomyia (Colombia)	Caraparu: *Oryzomys capito*, *Oryzomys laticeps*, *Proechimys guyanensis*, *Nectomys squamipes*, *Zygodontomys brevicauda*, *Heteromys anomalus*. Wyeomyia: "Mosquito."	Brazil, Colombia, Panama, Suriname, and Trinidad.	Caraparu transmission occurs during the rainy season (November to March) in tropical rain forests. Wyeomyia: unknown.	Leaf axils of terrestrial bromeliads.	Unknown.	Unknown.	Unknown.
"Mosquitoes"	Guaroa (Colombia, Peru)	Human isolate.	Colombia, Peru.	Unknown.	Unknown.	Unknown.	Unknown.	Unknown.
Culicoides paraensis (Diptera: Ceratopogonidae)	Oropouche	Primates (*Cebus*, *Alouatta*, *Saimiri*, *Saguinus*), sloths.	From sea level to elevations where tropical rain forests begin.	Epidemics occur during the rainy season (November to March).	Eggs are laid in decaying vegetable matter. Decaying banana stocks, cut-off banana stumps and piled up cacao pods are primary breeding sources in peridomestic settings and plantations. Rains provide moisture required for larval development in the decaying vegetation.	Exophagic or endophagic. Bites lower extremities, especially ankles. Inflicts painful bites capable of causing severe tissue reactions. Strictly daytime biters. Small peak at noon and large peak beginning 1 hour before and continuing to sunset. Increased activity right after rain showers.	Endophilic and exophilic.	Unknown, but probably less than 1 km.

Appendix A.3. (Cont'd)

VECTOR	ARBOVIRUS	ARBOVIRUS RESERVOIR	GEOGRAPHIC DISTRIBUTION	TRANSMISSION SEASON	LARVAL HABITAT	BITING BEHAVIOR	RESTING BEHAVIOR	FLIGHT RANGE
Lutzomyia spp. (Diptera: Psychodidae)	Arboledas (Colombia) Buenaventura (Colombia) Guama (Colombia, Peru) Mariquita (Colombia) Vesicular Stomatitis	Arboledas and buenaventura: unknown. Guama: *Oryzomys capito*, *Proechimys guyanensis*, *Nectomys squamipes*, *Oryzomys laticeps*, *Heteromys anomalus*, *Zygodontomys brevicauda*, *Coendou* spp. Mariquita: unknown. Vesicular Stomatitis: Poorly understood but primarily a disease of livestock (bovines and equines).	Colombia, Peru.	Arboledas, Buenaventura and Mariquita transmission coincides with increases in sand fly populations during the rainy season (November to March). Guama transmission occurs during the rainy season in tropical rain forests (November to March). Incubation period <10 days. Vesicular stomatitis virus activity begins at the end of the rainy season and disappears when the dry season is underway.	Unknown.	Unknown.	Unknown.	Unknown.
Simulium exiguum (Diptera: Simuliidae)	Vesicular Stomatitis	Poorly understood but primarily a disease of livestock (bovines and equines).	Colombia	Virus activity begins at the end of the rainy season and disappears during the dry season.	Unknown.	Unknown.	Unknown.	Unknown.

Appendix A.4. Vector Ecology Profile: Reduviid Vectors of Chagas' Disease in Bolivia.

VECTOR	GEOGRAPHIC DISTRIBUTION	POTENTIAL HOSTS	TRANSMISSION SEASON	BIONOMICS/HABITAT INFORMATION	BITING BEHAVIOR
Triatoma infestans	Widely distributed up to 4,100 m in the inter-Andean valleys. Reportedly replacing *T. sordida*.	Chickens, dogs and humans.	Peak adult emergence is February - April.	Domestic and peridomestic – rarely found in forest areas. Hides during day among household items (bed, clothing, etc.) and in thatched roofs and walls. Peridomestic infestations of poultry, pigeons, rabbit pens and also larger livestock shelters. Tolerates temperatures between 10°C - 37°C. Prefers warm climate and low humidity. Populations peak during rainy season. Life cycle includes 5 nymphal stages, and may extend over 2 years, including up to 16 months in the adult stage. All stages may become infective. As many as 240 eggs are laid freely, not glued to substrate surfaces. Two generations per year. Rests in cracks/crevices of upper walls and rafters/roof.	Strongly anthropophilic and zoophilic. Sylvatic host associations include didelphids, *Graomys, Microcavia and Galea* spp. Feeds on domesticated guinea pigs. Aggressive night feeder. Attracted to warmth and CO_2. Relatively painless bite with little reaction. Feeds every few weeks.
Panstrongylus megistus	Southeastern Bolivia.	Ground-nesting mammals, humans.	Unknown.	First demonstrated vector of Chagas' disease. Common domestic species. Peridomestic in chicken houses and many sylvatic habitats. Limited distribution because of requirement for high relative humidity. Moist climate, >60% relative humidity.	Strongly anthropophilic.
Triatoma sordida	Southern lowland areas of LaPaz and Santa Cruz (Gran Chaco) Departments.	Chickens, dogs, and humans.	Unknown.	Colonizes human dwellings, especially those associated with the species' common peridomestic habitats, e.g., chicken houses, pigeon coops, rat nests and sparrow and other wild bird nests. Eggs are not glued to substrates. Will replace *T. infestans* in areas where *T. infestans* is exterminated.	Opportunistically feeds on humans but prefers birds. Defecates on hosts within 10 minutes of feeding.
Triatoma guasayana	Southeastern Bolivia.	Unknown.	Unknown.	Primarily peridomestic. The presence of *T. infestans* tends to exclude *T. guasayana* from homes, but *T. guasayana* will infest homes when *T. infestans* is absent. Peridomestic habitats include chicken houses, pigeon coops, and livestock shelters. Dispersal flights begin in spring and continue through summer. Eggs are not attached to substrates.	Secondarily anthropophilic.

Appendix A.5. Vector Ecology Profile: Flea Vectors of Plague in Bolivia.

VECTOR	GEOGRAPHIC DISTRIBUTION	POTENTIAL HOSTS	TRANSMISSION SEASON	BIONOMICS/HABITAT INFORMATION	BITING BEHAVIOR
Xenopsylla cheopis	Primary vector at elevations below 2,800 m countrywide, although it may occur at higher elevations.	*Rattus rattus, Rattus norvegicus, Cavia porcellus.*	Unknown.	300-400 ovoid white eggs are deposited in the nest or burrow of the host at a rate of 2-6/day. The eggs hatch in 9-13 days. Three larval instars are legless and eyeless, lasting 32-34 days. Pupae spin a silken cocoon and adults emerge in 25-30 days. Development occurs in nest of host. Adults live up to 158 days at 20°C and 90-94% relative humidity.	Voracious feeder, feeding frequently for short periods. Proventricular blockage occurs below 27°C. Blockage occurs in 12-21 days after ingesting plague bacilli. Found to feed readily on 75 different hosts, including man. Can jump 20 cm. Burrowing *Rattus* spp. usually harbor more *X. cheopis* than those confined to surface habitats.
Pulex irritans and *P. simulans*	Implicated as primary urban vectors at elevations above 2,800 m.	*Rattus rattus, Rattus norvegicus, Cavia porcellus, Canis familiaris, Sus scrofa*.	Unknown.	Broader temperature tolerance than *X. cheopis*. Eggs laid indiscriminately in the environment in peridomestic settings. Larvae and pupae develop in the soil. Adults live free in the environment, accessing hosts by jumping on, feeding quickly and jumping off.	Blockage of the proventriculus rarely occurs in *Pulex* spp. Voracious feeders, feeding frequently. Can jump 30 cm.

Appendix A.6. Vector Ecology Profile: Sand Fly Vectors of Leishmaniasis in Bolivia.

VECTOR	GEOGRAPHIC DISTRIBUTION	POTENTIAL HOSTS	TRANSMISSION SEASON	BIONOMICS/HABITAT INFORMATION	BITING BEHAVIOR
Lutzomyia longipalpis (Vector of *L. chagasi*)	The Yungas of the LaPaz and Cochabamba Departments between 1,000-2,000 m. Three sibling species are thought to exist.	Wild and domestic mammals, cattle, humans.	Especially aggressive in Spring (Sep-Dec). Transmission primarily peridomestic. Infection rates higher in valley bottoms than on the slopes.	Rests/hides in caves, rock holes, crevices, etc. associated with dryer savanna-type habitats. Common in rural domestic and peridomestic environs. Frequently rests indoors. Maximum flight range ca. 0.5 km, but usually 50 to 300 m. The time from egg to adult is 20-41 days. Eggs laid in crevices. Successfully colonized. The optimal laboratory rearing temperature is 25°C.	Exophagic and endophagic. Endophilic in peridomestic settings. Opportunistic feeder, feeding on dogs, foxes, cattle and humans. Require 5-12 minutes to feed (laboratory). Females may feed twice during their lifespan. Biting activity begins shortly after sunset (1830-2330) and continues until sunrise. Activity decreases below 24°C.
Lutzomyia nuneztovari (Vector of *L. braziliensis braziliensis*)	The Andean foothills of La Paz Dept. at altitudes between 1,300 and 1,900 m.	Mammalian reservoirs are unknown.	Present throughout the year	Yungas primary forests where it occurs at ground and canopy levels. Also found in coffee plantations surrounding human dwellings.	Aggressive human biter the year around; endophagic. People may be bitten when clearing forests, harvesting Brazil nuts, or tapping rubber trees.
Lutzomyia flaviscutellata (Vector of *L. mexicana mexicana*)	Northeastern lowlands of the Departments of Beni and Pando.	Small mammals, humans.	Present throughout the year, but populations significantly increase toward end of dry season and decline as rainy season commences.	Occurs in dry secondary forests. Commonly rests on the forest floor. The time from egg to adult averages 40.5 days. Males emerge before females. Females and males live 17-41 days (ave. 27) and 2-12 days (ave. 6), respectively. Requires blood meal for egg development. Lay 165 eggs/female. This species has been colonized in the laboratory. At 95-98% relative humidity, the optimal larval and adult rearing temperatures are 20-26°C and 23-27°C, respectively.	Strongly attracted to rodents and marsupials, but will bite humans entering their habitat. Females will feed as many as four times during their lifespan. Successful biting collections have been conducted during the first four hours after dark.
Lutzomyia umbratilis (Vector of *L. guayanensis*)	Northeastern lowlands of the Amazon Basin in Departments of Pando and northern Beni.	Small ground dwelling mammals.	Unknown.	Adults found in primary rain forests. Adults collectible from ground level to 1.5 m on tree trunks. In French Guiana, commonly found on trunks of Niamboka (*Pouteria guianensis*) and Kopi (*Goupia glabra*) trees.	Mammal biter; probably feeds mainly on ground dwelling animals; will bite humans.
Lutzomyia carrerai carrerai (Vector of *L. b. braziliensis*)	Subandean lowlands and Amazon basin	Most likely small, arboreal mammals	Transmission takes place during the rainy season (September –March) in the primary rain forests.	Adults found in primary rain forests usually at levels of 5 to 10 meters above ground level.	Mammal biter; probably feeds mainly on ground dwelling animals; will bite humans.
Lutzomyia yucumensis (Vector of *L. b. braziliensis*)	Lowlands of Cochabamba and Santa Cruz Departments	Most likely small, arboreal mammals	Transmission takes place during the rainy season (September –March) in the primary rain forests.	Adults found in primary rain forests usually at levels of 5 to 10 meters above ground level.	Mammal biter; probably feeds mainly on ground dwelling animals; will bite humans.

Appendix A.6. (Cont'd)

VECTOR	GEOGRAPHIC DISTRIBUTION	POTENTIAL HOSTS	TRANSMISSION SEASON	BIONOMICS/HABITAT INFORMATION	BITING BEHAVIOR
Lytzomyia shawi (Infected with flagellates, species unconfirmed)	Lowlands of Cochabamba and Santa Cruz Departments	Unknown, probably small ground dwelling mammals.	Present year around in the primary rain forests with peak densities occuring in October, corresponding to the onset of the rainy season.	Collected mostly at ground level in primary rain forests.	Mammal biter; probably feeds mainly on ground dwelling animals; will bite humans.
Lutzomyia hirsuta hirsuta (Infected with flagellates, species unconfirmed)	Lowlands of Cochabamba and Santa Cruz Departments	Unknown.	Unknown.	Collected mostly at ground level in primary rain forests.	Mammal biter; probably feeds mainly on ground dwelling animals; will bite humans.

Appendix B: Arthropod Species

Appendix B.1: Species of Mosquitoes (Diptera: Culicidae) Reported from Bolivia*

Aedeomyia (*Aedeomyia*)
- *squamipennis*

Aedes (*Howardina*)
- *aurivittatus*
- *fulvithorax*
- *leei*
- *martenezi*
- *pseudodominicii*
- *vanemdeni*

Aedes (*Ochlerotatus*)
- *albifasciatus*
- *angustivittatus*
- *bejaranoi*
- *crinifer*
- *fluviatilis*
- *fulvus*
- *hastatus*
- *hortator*
- *milleri*
- *oligopistus*
- *pennai*
- *scapularis*
- *serratus*
- *stigmaticus*

Aedes (*Stegomyia*)
- *aegypti*

Anopheles (*Anopheles*)
- *apicimacula*
- *eiseni*
- *fluminensis*
- *mattogrossensis*
- *mediopunctatus*
- *peryassui*
- *pseudopunctipennis*
- *punctimacula*
- *shannoni*
- *tibiamaculatus*

Anopheles (*Kerteszia*)
- *bambusicolus*
- *boliviensis*
- *cruzii*
- *homunculus*
- *laneanus*
- *lepidotus*
- *neivai*

Anopheles (*Nyssorhynchus*)
- *albitarsis*
- *allopha*
- *argyritarsis*
- *braziliensis*
- *darlingi*
- *marajoara*
- *nuneztovari*
- *oswaldoi*
- *rangeli*
- *rondoni*
- *triannulatus*
- *trinkae*

Anopheles (*Stethomyia*)
- *nimbus*

Chagasia bonneae

Coquillettidia (*Rhynchotaenia*)
- *albicosta*
- *hermanoi*
- *juxtamansonia*
- *lynchi*
- *nigricans*
- *nitens*
- *shannoni*
- *venezuelensis*

Culex (*Carrollia*)
- *urichii*

Culex (*Culex*)
- *apicinus*
- *bidens*
- *chidesteri*
- *coronator*
- *declarator*
- *dolosus*
- *quinquefasciatus*
- *surinamensis*
- *usquatus*

Culex (*Lutzia*)
- *bigoti*

Culex (*Melanoconion*)
- *aliciae*
- *educator*
- *ensiformis*
- *glyptosalpinx*
- *idottus*
- *pilosus*
- *taeniopus*
- *theobaldi*

Culex (*Phenacomyia*)
- *corniger*

Culex (Subgenus Uncertain)
- *ocellatus*

Haemagogus (*Conopostegus*)
- *leucocelaenus*

Haemagogus (*Haemagogus*)
- *janthinomys*
- *spegazzinii*

Limatus durhamii

Mansonia (*Mansonia*)
- *amazonenesis*
- *flaveola*
- *humeralis*
- *indubitans*
- *titillans*

Orthopodomyia fascipes

Psorophora (*Grabhamia*)
- *cingulata*
- *confinnis*
- *dimidiata*
- *paulli*
- *varinervis*

Psorophora (*Janthinosoma*)
- *albigenu*
- *circumflava*
- *cyanescens*
- *discrucians*
- *ferox*
- *fiebrigi*
- *lanei*
- *lutzii*
- *melanota*

Psorophora (*Psorophora*)
- *ciliata*
- *cilipes*
- *pallescens*
- *saeva*

Runchomyia (*Ctenogoeldia*)
- *magna*

Sabethes (*Davismyia*)
- *petrocchiae*

Sabethes (*Peytonulus*)
- *identicus*
- *soperi*
- *undosus*

Sabethes (*Sabethes*)
- *albiprivus*
- *amazonicus*
- *belisarioi*
- *purpureus*
- *schnusei*

Sabethes (*Sabethinus*)
intermedius

Sabethes (*Sabethoides*)
chloropterus
glaucodaemon

Shannoniana fluviatilis
schedocyclia

Toxorhynchites (*Ankylorhynchus*)
hexacis

Toxorhynchites (*Lynchiella*)
guadeloupensis
haemorrhoidalis
theobaldi

Trichoprosopon compressum
digitatum
pallidiventer

Uranotaenia (*Uranotaenia*)
davisi
geometrica
hystera
lowii
nataliae
pulcherrima

Wyeomyia (*Dendromyia*)
ypsipola

Wyeomyia (*Dodecamyia*)
aphobema

Wyeomyia (*Exallomyia*)
tarsata

Wyeomyia
circumcincta
confusa
kerri
melanocephal
mystes
occulta
personata
undulata

***References: Knight and Stone 1977, Knight 1978**

Appendix B.2: Species of Sand Flies (Diptera: Psychodidae) Reported from Bolivia*

Lutzomyia (*Helocyrtomyia*)
- *galatiae*

Lutzomyia (*Lutzomyia*)
- *evangelistai*[1]
- *legerae*
- *longipalpus*[1, 6]
- *sherlocki*[1]

Lutzomyia (Species Group *Verrucarum*)
- *nevesi*[1]
- *nuneztovari*[1, 3, 5]
- *serrana*[1]

Lutzomyia (*Micropygomyia*)
- *micropyga*

Lutzomyia (Species Group *Oswaldoi*)
- *fonsecai*
- *peresi*
- *quinquefer*
- *rorotaensis*
- *trinidadensis*

Lutzomyia (*Nyssomyia*)
- *antunesi*[1]
- *flaviscutellata*[1, 4]
- *shawi*[1, 3]
- *umbratilis*[1, 4, 7, 8]
- *yuilli yuilli*[1]

Lutzomyia (*Pressatia*)
- *calcarata*
- *duncanae*
- *triacantha*

Lutzomyia (*Pifanomyia*)
- *guilvardae*

Lutzomyia (*Pintomyia*)
- *kuscheli*

Lutzomyia (*Psathyromyia*)
- *campbelli*[2]
- *dendrophyla*[1]
- *lerayi*
- *lutziana*
- *punctigeniculata*
- *shannoni*

Lutzomyia (Species Group *Aragaoi*)
- *abunaensis*
- *antezanai*
- *aragaoi*
- *barrettoi barrettoi*

Lutzomyia (Species Group *Dreisbachi*)
- *ruparupa*
- *aclydifera*

Lutzomyia (*Psychodopygus*)
- *amazonensis*[1]
- *ayrozai*[1]
- *carrerai carrerai*[1,5]
- *davisi*[1]
- *hirsuta hirsuta*[1, 3]
- *llanosmartinsi*[3]
- *nocticola*
- *yucumensis*[3,5]

Lutzomyia (Species Group *Saulensis*)
- *saulensis*

Lutzomyia (*Sciopemyia*)
- *servulolimai*
- *sordellii*
- *vattierae*

Lutzomyia (Species Group *Migonei*)
- *andersoni*
- *migonei*
- *sallesi*[1]
- *walkeri*

Lutzomyia (*Trichophoromyia*)
- *auraensis*
- *beniensis*
- *flochi*

velascoi

Lutzomyia (*Trichopygomyia*)

Lutzomyia (*Viannamyia*)
tuberculata[2]

Ungrouped *Lutzomyia*
boliviana
brisolai[1]
mollinedoi
torresi

Warileya
rotundipennis[1]
yungasi

dasypodogeton
gantieri

---

[1] Anthropophilic
[2] Likely occurs, but not confirmed
[3] *Leishmania* (species not confirmed)
[4] *Leishmania amazonensis*
[5] *Leishmania brasiliensis*
[6] *Leishmania chagasi*
[7] *Leishmania guyenensis*
[8] Phlebovirus

***Reference: Young and Duncan 1994**

Appendix B.3: Species of Kissing Bugs (Hemiptera: Reduviidae) Reported from Bolivia*

Eratyrus mucronatus [2] (east of Andes)

Microtriatoma trinidadensis [2]

Panstrongylus diasi
Panstrongylus geniculatus
Panstrongylus guentheri
Panstrongylus megistus [1] (southern Bolivia)
Panstrongylus rufotuberculatus

Psammolestes coreodes [2]

Rhodnius pictipes
Rhodnius prolixus [1]
Rhodnius robustus

Triatoma guasayana [1]
Triatoma infestans [1]
Triatoma platensis (southern Bolivia)
Triatoma sordida [1]

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[1] Species that colonize human habitations and are naturally infected with *Trypanosoma cruzi*.
[2] Little or no association with man.

***Reference: Brenner and Stoka 1987**

Appendix B.4: Species of Ticks and Their Hosts Reported from Bolivia*

Tick Species	**Hosts**
Argasidae	
Ornithodoros boliviensis	*Myotis nigricans* (bat), *Molossus major* (bat)
Ornithodoros echimys	*Marmosa* (bat)
Ornithodoros hasei	*Noctilio labialis* (bat)
Ornithodoros mimon	*Mimon crenulatum* (bat)
Ornithodoros rostratus	human
Ornithodoros stageri	*Noctilio labialis* (bat)
Ornithodoros talaje (probable)	
Otobius megnini	cattle
Ixodidae	
Amblyomma auricularium	*Chrysocyon* (maned wolf), *Tamandua* (anteater)
Amblyomma cajennense	dogs, horses, humans, *Philander* (opossum), *Calomys* (vesper mice)
Amblyomma calcaratum	*Tamandua tetradactyla* (anteater)
Amblyomma coelebs	*Tapirus* (tapir)
Amblyomma incisum	
Amblyomma longirostre	squirrels, *Coendou bicolor* (prehensile-tailed porcupine), *Coendou simonsi* (prehensile-tailed porcupine)
Amblyomma maculatum	
Amblyomma naponense	
Amblyomma nodosum	*Tamandua tetradactyla* (anteater)
Amblyomma oblongoguttatum	dogs
Amblyomma ovale	dogs, *Oryzomys* (rice rats), *Proechimys* (spiny rats), *Speothos venaticus* (bush dog)
Amblyomma parvitarsum	
Amblyomma parvum	humans
Amblyomma pecarium	*Tayassu pecari*
Amblyomma pseudoconcolor	*Euphractus sexcinctus* (six-banded armadillo)
Amblyomma rotundatum	tortoise
Amblyomma scalpturatum	
Amblyomma tigrinum	dogs, *Chrysocyon* (maned wolf)
Amblyomma triste	*Cerdocyon* (crab-eating fox)
Anocentor nitens	dogs, horses
Boophilus microplus	cattle
Haemaphysalis juxtakochi	*Cebus apella* (ring-tailed monkey)
Ixodes boliviensis	
Ixodes cooleyi	
Ixodes luciae	*Oryzomys* (rice rats), *Philander* (opossum)

***Reference: Doss et al. 1978**

Appendix B.5: Species of Fleas and Their Hosts Reported from Bolivia*

Flea Species	**Hosts**
Ctenophthalmidae	
Neotyphloceras crassispina hemisus	*Akodon* (grass mice)
Leptopsyllidae	
Leptopsylla segnis [1]	*Mus* (house/rice field mice)
Pulicidae	
Ctenocephalides canis [1]	*Canis* (dogs), *Felis* (cats)
Ctenocephalides felis felis [1]	*Canis* (dogs), *Felis* (cats), *Rattus* (rats)
Echidnophaga gallinacea	Chickens, *Sus* (pigs)
Hectopsylla coniger	*Conepatus* (hog-nosed skunks)
Pulex irritans [1]	humans, *Canis* (dogs), *Felis* (cats) *Cavia* (guinea pigs), *Conepatus* (hog-nosed skunks), *Lagostomus* (plains viscacha)
Pulex simulans [1]	*Cavia* (guinea pigs)
Tunga penetrans [1]	humans, *Sus* (pigs)
Xenopsylla cheopis [1]	*Cavia* (guinea pigs), *Rattus* (rats)
Rhopalopsyllidae	
Ectinorus pearsoni	*Akodon* (grass mice), *Phyllotis* (leaf-eared mice)
Ectinorus simonsi	
Gephyropsylla klagesi samuelis	*Proechimys* (spiney rats)
Polygenis atopus	*Euryzygomatomys* (guiara)
Polygenis bohlsi bohlsi	*Oryzomys* (rice rats)
Polygenis byturus	Didelphid marsupials
Polygenis dendrobius	
Polygenis platensis cisandinus	*Galea* (yellow-toothed cavies)
Polygenis roberti beebei	Multiple hosts
Polygenis roberti tripopsis	
Polygenis trapidoi mendezi	*Graomys*
Polygenis tripus	*Graomys*
Rhopalopsyllus australis tamoyus	*Dasyprocta* (agoutis)
Rhopalopsyllus australis tupinus	*Dasypodidae* (armadillos)
Rhopalopsyllus crypturi	*Dasyprocta* (agoutis)
Rhopalopsyllus cacicus	Didelphid marsupials
Rhopalopsyllus lugubris lugubris	*Dasyprocta* (agoutis), *Didelphis* (opossums)
Tiamastus cavicola [2,3]	*Cavia* (guinea pigs), *Oligoryzomys*, *Rattus* (rats)

Stephanocircidae

Nonnapsylla rothschildi rothschildi	
Plocopsylla enderleini	*Chinchillula* (altiplano chinchilla mouse)

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[1]Anthropophilic
[2]Found naturally infected with plague
[3]Transmitted plague experimentally in the laboratory
Genera of known host(s) and their common names are listed to the right of each species. Bat and bird fleas have not been implicated in disease transmission and are not included.

***References: Johnson 1957, Lewis 1972, 1973, 1974a, b, c, 1975**

Appendix B.6: Species of Black Flies (Diptera: Simuliidae) Reported from Bolivia*

Simulium (*Coscaroniellum*)
quadrifidum

Simulium (*Cerqueirellum*)
argentiscutum

Simulium (*Ectemnaspis*)
antonii
bicoloratum
ignescens
roquemayu
rubiginosum

Simulium (*Hemicnetha*)
mexicanum
seriatum

Simulium (*Notolepria*)
exiguum

Simulium (*Psaroniocompsa*)
jujuyense

Simulium (*Psilopelmia*)
dinellii
lutzianum
wolffhuegeli

Simulium (*Pternaspatha*)
barbatipes
bordai
prodexargenteum
dureti

Simulium (*Trichodagmia*)
chalcocoma
huairayacu

Simulium lurybayae

***Reference: Kim and Merritt 1987**

Appendix B.7: Species of Scorpions Reported from Bolivia*

Bothriuridae

Bothriurus bocki (LaPaz, Cochabamba, Potosi, and Chuquisaca Departments)
Bothriurus inermis
Bothriurus maculatus

Buthidae

Tityus argentinus (Cochabamba, Santa Cruz Departments and the Yungas)
Tityus bolivianus (LaPaz Department)
Tityus simonsi (Cochabamba Department)
Tityus soratensis (LaPaz Department)

***Reference: Polis 1990**

Appendix C: Venomous Snakes of Bolivia*, **

Elapidae

Micrurus annellatus (western and central Bolivia)
Micrurus corallinus [1, 4, 6] (Brazilian coral snake, likely occurs in southeastern Bolivia, but unconfirmed)
Micrurus frontalis [1, 4, 6, 10] (giant coral snake, Serrania de Santiago and west and southwestern Bolivia)
Micrurus frontifasciatus (eastern slopes of Andes)
Micrurus hemprichii (upper Amazon drainages)
Micrurus ibiboboca (upper Amazon drainages of northeastern Bolivia)
Micrurus langsdorffi (upper Amazon drainages of northeastern Bolivia)
Micrurus lemniscatus helleri [6] (Amazon region)
Micrurus narduccii (southeastern lowlands Santa Cruz Department)
Micrurus spixii [6] (upper Amazon of northwestern and central Bolivia)
Micrurus surinamensis (Amazon region)

Viperidae

Bothriopsis bilineata (emerald pit viper)
Bothriopsis oligolepis
Bothriopsis peruviana (northern Bolivia)
Bothriopsis taeniata (east of Andes)
Bothrops andianus (northwestern Bolivia, 2,400-3,000 m)
Bothrops atrox [2, 6, 8, 9, 10, 11] (barba amarilla, northern equatorial forests)
Bothrops brazili (equatorial forests)
Bothrops jararacussu [1, 2, 3, 4] (southeastern Bolivia)
Bothrops microphthalmus (Amazonian forests)
Bothrops moojeni [2, 3, 4] (Moojen's viper, likely occurs in southeast savannas, but not confirmed)
Bothrops neuwiedi [1, 2, 3, 4] (Wied's lance head viper, eastern Bolivia)
Bothrops sanctaecrucis (Beni and Santa Cruz Departments)
Crotalus durissus terrificus [1, 2, 3, 4, 5, 6, 8] (tropical rattlesnake, in dry regions of eastern central Bolivia)
Lachesis muta [2, 4, 6, 9, 11] (bushmaster, equatorial forests)

Superscript numbers following species names refer to antivenoms available from corresponding antivenom providers listed in Appendix E.

***Reference: Campbell and Lamar 1993**
****Additional information on venomous snakes is available on AFMIC's MEDIC CD-ROM**

Appendix D: Sources of Snake Antivenoms*

Argentina - 1
Instituto Nacional de MicrobiologRa
"Dr. Carlos G. Malbran"
Av. Velez Sarsfield 563
Buenos Aires, Argentina

Brazil – 2
FundaHno Ezequiel Dias
Rua Conde Pereira
80-Gameleira 30550
Belo Horizonte-MG Brazil
TEL: (031) 332-2077
FAX: (031) 332-2534
TELEX: 392417 FEDS BR

Brazil – 3
Institutos Vital Brazil S.A.
Caixa Postal 28
Niteroi, Rio de Janeiro, Brazil
TEL: 55212558688

Brazil - 4
Instituto Butantan
Av. Dr. Vital Brazil, 1500
Caixa Postal 65
CEP 01051
Sno Paulo, SP, Brazil
FAX: (011) 815-1505
TELEX: (011) 83325 BUTA BR

Colombia - 5
Instituto Nacional de Salud
Av. Eldorado con Carrera 50, Zona 6
Bogot<, Colombia
FAX: 57-1-2220975
TEL: 57-1-2220577, ext. 147

Costa Rica - 6
Instituto Clodomiro Picado
Universidad de Costa Rica
Ciudad Universitaria "Rodrigo Facio"
San JosJ, Costa Rica
FAX: (506) 29-31-35
TEL: (506) 29-03-44

Ecuador - 7
Instituto Nacional de Higiene y
Medicina Tropical
"Leopoldo Izquieta PJrez"
Casilla Postal 3961
Guayaquil, Ecuador

Mexico – 8
Zapata Laboratories
Mexico City, Mexico
TEL: 592-82-70
TEL: 561-12-11
TEL: 592-88-93

Pennsylvania, U.S.A. – 9
Wyeth International Ltd.
P.O. Box 8299
Philadelphia, PA 19101-1245
TEL: (215) 688-4400

Peru - 10
Instituto Nacional de Hygiene
Lima, Peru

Peru – 11
Institutos Nacionales de Salud
Departamento de Animales Venenosos
Calle Capac Yupanqui 1400
Apartado 451
Lima, Peru
TEL: (51) 14416141
TEL: (51) 14678212
TEL: (51) 14311130

***Additional information on antivenoms is available on AFMIC's MEDIC CD-ROM**

Appendix E: Plants of Bolivia that Cause Contact Dermatitis*

Agave spp. (sap of leaves- saponin)
Ammannia spp., aquatic plants
Anacardium occidentale, cashew nut, maranon (nut, bark, leaves - anacardic acid)
Calophyllum inophyllum, lagarto caspi, tornillon
Caloptropis spp., found in dry open areas, milkweed (milky sap)
Comocladia spp.
Croton spp., sangre de grado (resinous oil)
Dalechampia spp., vines in disturbed areas, manicillo
Daphne spp. (sap - mezercin)
Euphorbia spp. (sap - euphorbin)
Hura spp., catahua (sap)
Jatropha spp., ortiga, nettle (leaves)
Malpighia spp., found in dry deciduous forests
Ricinus spp., castor bean (dust of seeds)
Schinus spp., found in inter-Andean valleys
Sterculia spp., huarmi
Thevetia peruviana (seeds, leaves, stems and roots)
Toxicodendron spp., itil, incati, maico poison oak, poison ivy (leaves, bark, sap)
Urera spp., urticating nettle, ishanga, mara mara

***Additional information on vegetation is available on AFMIC's MEDIC CD-ROM**

Appendix F: Plants of Bolivia that are Toxic when Ingested*

Abrus spp., a woody liana (seeds and roots - sea level-300 m)
Ageratina altissima
Anacardium occidentale, cashew nut, maranon (nut and shell - anacardic acid)
Brugmansia spp., tree-like (seeds)
Calophyllum inophyllum, lagarto caspi, tornillon
Caloptropis spp., found in dry open areas (milkweed)
Coriaria spp., sprawling shrub in open areas, woody lianas in forest (small fruits – corianmyratine)
Crotalaria spp., sangre de grado
Croton spp.
Daphne spp.
Datura spp. (seeds-scopolamine and hyoscyamine)
Dioscorea bulbifera (bulbs, if eaten uncooked)
Duranta spp., weedy herbs in dry areas
Euphorbia spp. (sap and seeds)
Heliotropium spp., heliotrope
Hura spp., tronador, sandbox, catahua (sap, seeds and bark)
Jatropha spp., ortiga, nettle (seeds)
Manihot esculenta, manihot, yuca (uncooked roots - hydrocyanic acid)
Phytolacca spp., airambo
Pilocarpus spp. (pilocarpine nitrate poisoning)
Pilea spp., found in cloud forests, some are epiphytic
Ricinus spp., castor bean (seeds, leaves and stems)
Sapium spp., guta percha (sap)
Schinus spp., found in inter-Andean valleys
Solandra spp., found in cloud forests and lowland wet forests
Solanum spp., siucahuito, coconillo, cocona, tintona (fruits and leaves)
Strychnos spp., canopy lianas, strychnus (contains curare alkaloids)
Thevetia peruviana, found in inter-Andean valleys (seeds, leaves, stems and roots)
Toxicodendron spp., poison oak, poison ivy, itil, incati, maico (seeds, leaves, and bark)

***Additional information on vegetation is available on AFMIC's MEDIC CD-ROM**

Appendix G: Selected List of Identification Keys

Argasidae/Ixodidae

Fairchild, G.V., G.M. Kohls and V.J. Tipton. 1966. The Ticks of Panama (Acarina: Ixodoidea), pp 167-219. *In*: R.L. Wenzel and V.J. Tipton (Eds.), Ectoparasites of Panama. Field Museum of Natural History, Chicago.

Jones, E. K., and C. M. Clifford. 1972. The Systematics of the Subfamily Ornithodorinae (Acarina: Argasidae). V. A Revised Key to Larval Argasidae of the Western Hemisphere and Description of Seven New Species of *Ornithodoros*. Ann. Ent. Soc. Am., 65(3): 730-40.

Jones, E.K., C.M. Clifford, J.E. Keirans and G.M. Kohls. 1972. The Ticks of Venezuela (Acarina: Ixodoidea) with a Key to the Species of *Amblyomma* in the Western Hemisphere. Brigham Young Univ. Sci. Bull., Biol. Ser., 17(4): 1-40.

Keirans, J.E., H. Hoogstraal and C.M. Clifford. 1979. Observations on the Subgenus *Argas* (Ixodoidea: Argasidae: *Argas*). 16. *Argas* (*A.*) *moreli*, New Species, and Keys to Neotropical Species of the Subgenus. J. Med. Ent., 15(3): 246-52.

Culicidae

Arnell, J.H. 1973. Mosquito Studies (Diptera, Culicidae). XXXII. A Revision of the Genus *Haemagogus*. Contrib. Am. Ent. Inst., 10(2): 1-174.

Dodge, H.R. 1962. Supergeneric Groups of Mosquitoes. Mosquito News, 22(4): 365-68.

Faran, M.E. 1980. Mosquito Studies (Diptera, Culicidae) XXXIV. A Revision of the Albimanus Section of the Subgenus *Nyssorhynchus* of *Anopheles*. Contrib. Am. Ent. Inst., 15(7): 1-215.

Faran, M.E. and K.J. Linthicum. 1981. A Handbook of the Amazonian Species of *Anopheles* (*Nyssorhynchus*) (Diptera: Culicidae). Mosq. Syst., 13(1): 1-81.

Gorham, J.R., C.J. Stojanovich and H.G. Scott. 1973. Illustrated Key to the Anopheline Mosquitoes of Western South America. Mosq. Syst., 5: 97-123.

Lane, J. 1953. Neotropical Culicidae. Volumes I & II, Sno Paulo, Univ. Sno Paulo.

Levi-Castillo, R. 1951. Los Mosquitos del Genero *Haemagogus* Williston, 1896 en America del sur. Editorial “Don Bosco,” Cuenca, Ecuador. 76 pp.

Linthicum, K.J. 1988. A Revision of the *Argyritarsis* Section of the Subgenus *Nyssorhynchus* of *Anopheles*. Mosq. Syst., 20(2): 98-271.

Pecor, J.E., V.L. Mallampalli, R.E. Harbach and E.L. Peyton. 1992. Catalog and Illustrated Review of the Subgenus *Melanoconion* of *Culex* (Diptera: Culicidae). Contrib. Am. Ent. Inst., 27: 1-228.

Sirivanakarn, S. 1982(1983). A Review of the Systematics and Proposed Scheme of Internal Classification of the New World Subgenus *Melanoconion* of *Culex* (Diptera: Culicidae). Mosq. Syst., 14(4): 265-333.

Zavortink, J.J. 1970. Mosquito Studies (Diptera, Culicidae) XIX. The Treehole *Anopheles* of the New World. Contrib. Am. Ent. Inst., 5(2): 135.

Zavortink, J.J. 1973. Mosquito Studies (Diptera, Culicidae) XXIX. A Review of the Subgenus *Kerteszia* of *Anopheles*. Contrib. Am. Ent. Inst., 9(3): 1-54.

Mammalia

DeBlase, A.F. and R.E. Martin. 1974. A Manual of Mammalogy, with Keys to Families of the World. Wm. C. Brown Company Publishers, Dubuque, Iowa, 329 pp. (Mammal trapping and ectoparasite collecting techniques, study skin preparations, and keys to family level).

Emmons, L.H. and F. Feer. 1997. Neotropical Rainforest Mammals, A Field Guide, 2nd Edition, Univ. Chicago Press, Chicago, 307 pp. (Family and generic keys – excellent detailed color illustrations of many species).

Fisler, G.F. 1970. Keys to Identification of the Orders and Families of Living Mammals of the World. Los Angeles County Museum of Natural History, Science Series, 25(2): 1-29. (Order and family keys).

Lawlor, T.E. 1976. Handbook of the Orders and Families of Living Mammals. MAD River Press, Eureka, California, 244 pp.

Redford, K.H. and J.F. Eisenberg. 1992. Mammals of the Neotropics, the Southern Cone. Vol. 2, Chile, Argentina, Uruguay, Paraguay, Univ. Chicago Press, Chicago, 430 pp. (Generic keys and index to common names).

Plants

Gentry, A.H. 1993. A Field Guide to the Families and Genera of Woody Plants of Northwest South America (Colombia, Ecuador, Peru) with Supplementary Notes on Herbaceous Taxa, Univ. Chicago Press, Chicago, 895 pp.

Psychodidae

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Appendix H: Personal Protective Measures

Personal protective measures are the first line of defense against arthropod-borne disease and, in some cases, may be the only protection for deployed military personnel. Proper wearing of the uniform and appropriate use of repellents can provide high levels of protection against blood-sucking arthropods. The uniform fabric provides a significant mechanical barrier to mosquitoes and other blood-sucking insects. Therefore, the uniform should be worn to cover as much skin as possible if weather and physical activity permit. When personnel are operating in tick-infested areas, they should tuck their pant legs into their boots to prevent access to the skin by ticks, chiggers, and other crawling arthropods. They should also check themselves frequently for ticks and immediately remove any that are found. If a tick has attached, seek assistance from medical authorities for proper removal or follow these guidelines from TIM 36, Appendix C:

1. **Grasp the tick's mouthparts** where they enter the skin, using pointed tweezers.

2. **Pull out** slowly and steadily with gentle force.

    a. Pull in the reverse of the direction in which the mouthparts are inserted, as you would for a splinter.

    b. **Be patient –** The long, central mouthpart (called the hypostome) is inserted in the skin. It is covered with sharp barbs, sometimes making removal difficult and time consuming.

    c. Many hard ticks secrete a cement-like substance during feeding. This material helps secure their mouthparts firmly in the flesh and adds to the difficulty of removal.

    d. It is important to continue to pull steadily until the tick can be eased out of the skin.

    e. **Do not** pull back sharply, as this may tear the mouthparts from the body of the tick, leaving them embedded in the skin. If this happens, don't panic. Embedded mouthparts are comparable to having a splinter in your skin. However, to prevent secondary infection, it is best to remove them. Seek medical assistance if necessary.

    f. **Do not** squeeze or crush the body of the tick because this may force infective body fluids through the mouthparts and into the wound.

    g. **Do not** apply substances like petroleum jelly, fingernail polish remover, repellents, pesticides, or a lighted match to the tick while it is attached. These materials are either ineffective or, worse, may agitate the tick and cause it to salivate or regurgitate infective fluid into the wound site.

h. If tweezers are not available, grasp the tick's mouthparts between your fingernails, and remove the tick carefully by hand. Be sure to wash you hands -- especially under your fingernails -- to prevent possible contamination by infective material from the tick.

2. Following removal of the tick, **wash the wound** (and your hands) with soap and water and **apply an antiseptic**.

3. **Save the tick** in a jar, vial, small plastic bag, or other container for identification should you later develop disease symptoms. Preserve the tick by either adding some alcohol to the jar or by keeping it in a freezer. Storing a tick in water will not preserve it. Identification of the tick will help the physician's diagnosis and treatment, since many tick-borne diseases are transmitted only by certain species.

4. **Discard** the tick after one month; all known tick-borne diseases will generally display symptoms within this time period.

Newly developed repellents provide military personnel with unprecedented levels of protection. An aerosol formulation of permethrin (NSN 6840-01-278-1336) can be applied to the uniform according to label directions, but not to the skin. This will impart both repellent and insecticidal properties to the uniform material that will be retained through numerous washings. An extended formulation lotion of N,N-diethyl-m-toluamide (deet) (NSN 6840-01-284-3982) has been developed to replace the 2 oz. bottles of 75% deet in alcohol. This lotion contains 33% active ingredient. It is less irritating to the skin, has less odor and is generally more acceptable to the user. A properly worn Battle Dress Uniform (BDU) impregnated with permethrin, combined with use of extended duration deet on exposed skin, has been demonstrated to provide nearly 100% protection against a variety of blood-sucking arthropods. This dual strategy is termed the DoD INSECT REPELLENT SYSTEM. In addition, permethrin may be applied to bednets, tents, and other field items as appropriate. Complete details regarding these and other personal protective measures are provided in TIM 36, *Personal Protective Techniques Against Insects and Other Arthropods of Military Significance* (1996).

Appendix I: Points of Contact for Bolivia

U.S. Embassy
Consulate
2780 Avenida Arce
La Paz, Bolivia
Telephone (591)(2)43-0251

U.S. Embassy
Consulate
Edificio Oriente, Room 313
Santa Cruz, Bolivia
Telephone (591)(03)33-0725

U.S. Embassy
Consulate
Avenida Oquendo 564
Edificio Sofer, Room 601
Cochabamba, Bolivia
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